THE ILLUMINATING ENGINEER

LIGHT LAMPS FITTINGS AND ILLUMINATION

THE JOURNAL OF

GOOD LIGHTING

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by LEON GASTER

. OIL . GAS ELECTRICITY ACETYLENE PETROL-AIR GAS ETC.

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Artificial Light as an aid to Aerial Navigation—The Standard Specification for Street Lighting—Visit to the G.E.C. Research Laboratories, Wembley—The Problem of Public Lighting by Electricity—National Illumination Committee (Annual Report)—The British Industries Fair—News from Abroad—Reviews of Books, etc.

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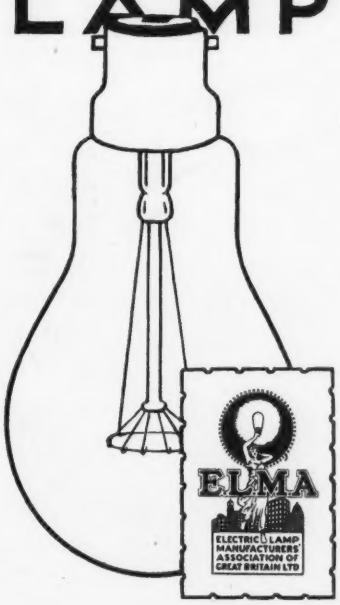

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Illuminating Engineering—The Past and the Future

THE meeting of the Institution of Electrical Engineers on March 3rd was given up to illuminating engineering, a paper on this subject being read by Mr. J. W. T. Walsh, and a second paper dealing with "The Problems of Public Lighting by Electricity" presented by Mr. Haydn T. Harrison. This, we believe, is the first occasion for many years on which the Institution has specifically devoted an ordinary meeting to lighting, though the writer and others have been responsible for informal talks on the subject. In general the discussion of lighting problems has been left to the Illuminating Engineering Society, and has formed its special province.

The meeting on March 3rd may therefore be construed as a recognition of the growing importance of the subject. We think, however, that it might have aided the discussion of the papers if an official invitation had been extended to members of the Illuminating Engineering Society, at whose meetings the presence of representatives of kindred bodies has often been found very helpful.

The paper itself consisted mainly of a survey of developments which are familiar to members of the Illuminating Engineering Society, having been frequently reviewed in this journal. We notice some omissions. Mr. Walsh refers to the formation of the Illumination Research Committee in 1923, but he makes no reference of the services of those who were responsible for establishing this Committee. He seems also to be unaware of the fact that this Committee was a revival of the Committee on Illuminating Engineering set up by the Department of Scientific and Industrial Research, in response to a request conveyed by a deputation of seven members of the Illuminating Engineering Society, on March 6th, 1917. The Committee devoted itself primarily to problems arising through war conditions. It was dissolved after the termination of hostilities, and has now been replaced by the Illumination Research Committee.

Elsewhere Mr. Walsh furnishes a lucid exposition of principles of lighting which have been evolved to a great extent at meetings of the Illuminating Engineering Society, but he again fails to make any adequate reference to the work of the Society, which is dismissed in a few lines. The most novel item in the paper is the process of treating glare, based on Bordoni's researches, which has been adopted in the B.E.S.A. Street-Lighting Specification.

To some of our readers these comments may appear unduly critical, but the matter is more important than it may appear, because it involves fundamental differences in outlook. As explained by the writer in the course of the discussion, the Illuminating Engineering Society has always welcomed the co-operation of the younger generation in the illuminating engineering movement, and the writer has taken every opportunity of urging that efforts should be made to enlist their loyal support. But one observes a tendency on the part of some who have only recently identified themselves with illuminating engineering to overlook the services of those responsible for the hard work of building up the movement, and to depart from the methods which have raised the Society to its present position.

The whole basis of existence of the Society rests on the preservation of an impartial platform and on the joint efforts of those interested in different systems of lighting, and in various aspects of illumination. Mrs. Sidney Webb, one of the greatest experts on social economics, once described the Illuminating Engineering Society as almost unique in the fact that it afforded equal opportunities for supplier and user. If the Society were ever to lose this impartial position and become a mere adjunct of some existing professional or trade organization its opportunities for usefulness to the lighting industry and to the public would be enormously diminished, and its prestige would be gone.

The founders of the Illuminating Engineering Society also recognized that illumination can never be regarded as a purely engineering process; that the solution of lighting problems requires the co-operation of architects, medical men and others with special knowledge of physiological and mental reactions to light; and that the views of the user, even if uninformed of technical points, deserve to be taken into account. Some of the most successful meetings of the Illuminating Engineering Society have been those in which the outside specialists have taken a leading part.

This view of the functions of the Society we believe to be the true one. It is directly opposed to the conception of a small assembly of "illuminating engineers" claiming a professional status which would meet with scant recognition from the public for many years to come.

The present needs of the Society are evident. It requires a much larger membership. We would, therefore, urge members who have opportunities of giving lectures or reading papers before outside bodies to make this an opportunity of interesting others in its work. The Society also needs much greater financial support in order that adequate trained assistance may be secured to enable it to extend its operations; but such support must be given with the clear recognition that its impartial position is to be maintained.

The Standard Specification for Street-Lighting

READERS of this journal will recall the classic paper read before the Illuminating Engineering Society in 1913 by Mr. A. P. Trotter, reviewing the draft clauses for inclusion in a standard specification for street lighting, as prepared by the joint committee composed of representatives of the Illuminating Engineering Society, the Institutions of Gas and Electrical Engineers, and the Institution of County and Municipal Engineers. This may be said to be the first attempt in this country to frame a standard specification for street lighting. The clauses were only presented after detailed discussion of every possible aspect, and in response to the unanimous feeling of the societies represented on the Joint Committee, that the impartial platform of the Illuminating Engineering Society was the only suitable one for an adequate discussion. All this work thus paved the way for the efforts of the B.E.S.A. Sub-Committee, which has now drafted a specification. Very wisely the Committee determined to present the report in draft form for comment by the various bodies interested. At the meeting of the Institution of Electrical Engineers, on March 3rd, Mr. C. C. Paterson (Chairman of the Sub-Committee) presented a summary of the terms of the specification, and he again did so at the meeting of the Illuminating Engineering Society held at the G.E.C. Research Laboratories on March 8th.

On p. 106 we give a brief review of the proceedings on the latter occasion, and we shall give, in due course, a fuller account of the discussion. For the moment we only propose to comment on a few salient points arising therefrom.

In the first place, we would like to see incorporated in the preface to the specification some reference to Mr. Trotter's well-known paper. In opening the discussion Mr. Paterson made generous acknowledgment of the value of this past work to the members of the present committee. It is only fitting that some similar reference should be made in the preface to the B.E.S.A. specification now presented, which is necessarily based to a great extent on the pioneering work of the past. At present anyone unfamiliar with developments prior to the war would naturally assume that the B.E.S.A. specification represents the first effort in this direction, and they would overlook a great deal of useful discussion which would help to amplify and explain many points to which only cursory reference is made.

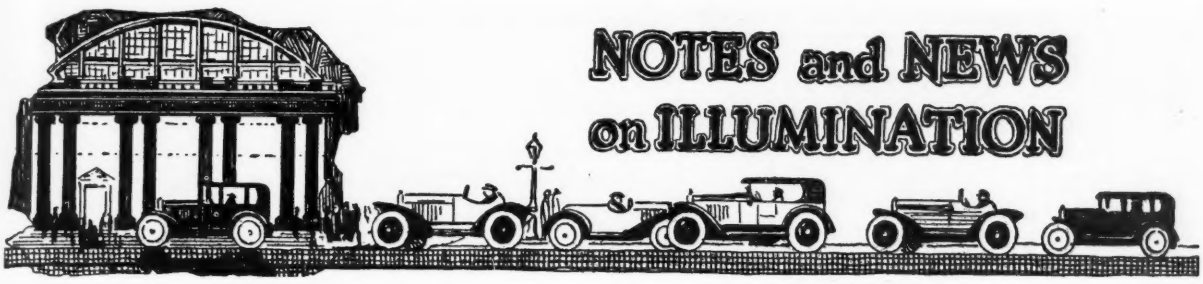
It was generally agreed that the discussion before the Illuminating Engineering Society was a very useful and instructive one. Those present appreciated the manner in which the Committee has discharged its difficult task, one commendable feature being the simplicity of the specification as a whole. The method of rating streets in terms of minimum horizontal (mid-span) illumination is again adopted. The classification is, however, somewhat extended, Class A being indicated by a minimum illumination of 2 foot-candles. We must confess that, although we desire to see every encouragement given to higher illuminations, this figure seems somewhat optimistic. The need at the moment is rather to improve the illumination of the lower classes of streets, which is often disproportionately low. At the moment the B.E.S.A. Committee do not attempt to classify streets according to traffic requirements. Perhaps the time is scarcely ripe for this step. But we hope that before long this will be taken in hand. Some of the worst cases of inadequate public lighting are streets which have altered in character. From roads of small importance they have become important arteries of traffic, requiring correspondingly better illumination.

Most experts would probably now agree that if a single criterion of illumination is adopted the minimum horizontal illumination is the best value to measure. Yet we must not forget the keen controversy aroused by this suggestion in 1913, and the strong objection taken to the method by some of the gas engineers. If the B.E.S.A. Committee has been successful in removing these objections and in achieving agreement on the part of all concerned they deserve great credit. But it seems likely that in some quarters it will still be considered anomalous to ignore completely the average illumination in a street, and possibly the inclusion of this as a supplementary basis of rating might still be considered.

This leads to another important consideration—the "grading" of the illumination. It is in the highest degree desirable that there should be no *sudden* contrasts in illumination in a street, and some speakers suggested that a numerical indication of adequate grading should be included; it might, for instance, be specified that the illumination should not vary by more than a certain percentage over a given length of roadway, and that the contrast in passing from a main street to a side street, or vice versa, should not exceed a certain amount.

This question of contrast really goes to the root of successful street lighting, and is the main consideration to be borne in mind in assessing effects of glare. We are glad to see that the Committee include a general requirement that "installations should be free from objectionable glare." The series of minimum heights prescribed for the various classes of streets is a help in this direction. But we confess we feel less happy about the empirical method of determining the "glare factor" presented in the appendix. We imagine that the average contractor will be not a little mystified by the array of curves, and that his confidence will not be increased by the fact that the full basis of the method is not explained, but is tucked away as an incidental item in Mr. Walsh's paper before the Institution. Even Mr. Walsh's method is itself based on the application of Professor Bordoni's researches (which, we believe, are still being verified), and the derived assumption that in street lighting glare may be regarded as dependent on the candle-power of the source only, irrespective of whether the filament is bare or screened. Experiments made in a laboratory may prove to have little bearing on the influence of glare as experienced by the driver of a rapidly moving motor-car. We hope that the impression will not be formed that the specification attaches no importance to the screening of filaments by diffusing glassware. We have no hesitation in saying that from the standpoint both of the driver and the pedestrian the screening of filaments is of fundamental importance; even the substitution of internally frosted lamps for clear bulbs has a material effect in reducing glare.

We make these suggestions as a contribution to the general discussion, which the Committee will no doubt study and apply, but we quite recognize that the Committee have had an exceedingly difficult task to perform, and that the specification is to some extent an experimental one, which may require modification as experience develops.



Illuminating Engineering Society

NOMINATION OF MR. D. R. WILSON AS PRESIDENT.

We are authorized to state that Mr. D. R. Wilson has been unanimously nominated by the Council of the Illuminating Engineering Society as President, in succession to the late Mr. C. H. Wordingham, C.B.E. This nomination will be presented for endorsement at the forthcoming annual general meeting.

Mr. D. R. Wilson has been a Member of the Council of the Society for many years, during which time he has rendered signal services to illuminating engineering. He has done much valuable pioneering work on industrial lighting. The Report of H.M. Chief Inspector of Factories for 1911 contained a special report by Mr. D. R. Wilson on "Illumination in Factories," occupying nearly 40 pages, and containing much useful statistical data and suggestions on various industrial lighting problems. The annual report for the subsequent year (1912) again included a special report by Mr. Wilson on "The Artificial Lighting of Iron Foundries."

In the following year, in conjunction with Mr. L. Gaster, he took an active part in the formation of the Home Office Departmental Committee on Lighting in Factories and Workshops, of which he became secretary. After the issue of the third report of this Committee he was one of those appointed by the Home Office to confer with Joint Industrial Councils and took a leading part in the work of bringing before them the benefits of good industrial lighting. As secretary of the Industrial Fatigue Research Board he has made many contributions to the study of industrial hygiene and efficiency.

He has also taken an active part in initiating many of the investigations of the Illumination Research Committee, working under the Department for Scientific and Industrial Research, of which he is a member; and we are betraying no secret in mentioning that he rendered very substantial aid in connection with the reconstruction of this Committee.

The traditions of the Illuminating Engineering Society render it eminently desirable that its President should be one occupying an entirely impartial position, and we feel sure that the nomination of Mr. Wilson, which will be put forward by the Council, will receive the cordial support of the members of the Society.

RECENT MEETINGS AND FORTHCOMING ONES.

During the past month the members of the Illuminating Engineering Society held two specially interesting meetings, the visit to the G.E.C. Research Laboratory on March 8th, which was followed by a discussion on the Street-Lighting Specification, and the gathering at the E.L.M.A. Lighting Service Bureau on March 22nd, which was devoted to a discussion of miscellaneous lighting problems. Both events proved to be exceptionally enjoyable. The inspection of the Research Laboratories under the guidance of the Director, Mr. C. C. Paterson, and his staff was a treat to which many members had looked forward, and the subsequent discussion on the Street-Lighting Specification was generally regarded as a very informative one. At the subsequent meeting, which will be dealt with *in extenso* in our next number, a series of problems, such as decorative lighting, cornice lighting, and the illumination of a greyhound racing track, was successively dealt with by different authors, the sequence of short items presenting plenty of variety. There is a good deal to be said for the plan of holding meetings at different places. We understand that forthcoming events include a discussion on the question of the relation between illumination and the efficiency of fine work (recently dealt with in the report of the Illumination Research Committee, which aroused so much interest), and a visit to the National Physical Laboratory, when various photometric subjects will be dealt with.

Department of Scientific and Industrial Research

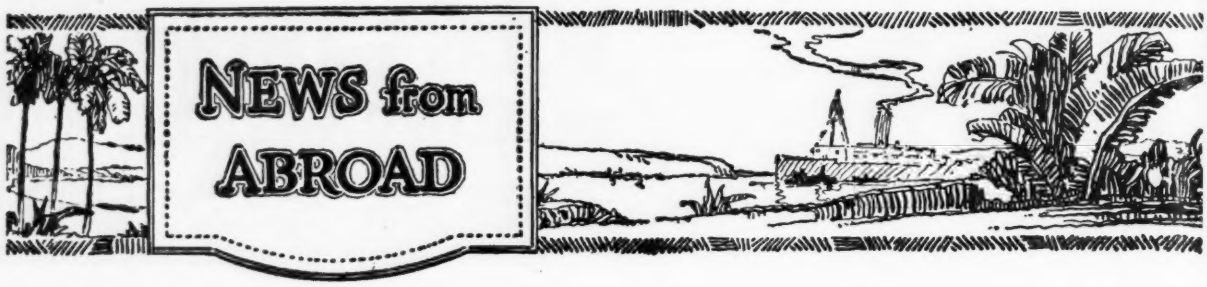
We are informed that Mr. Henry Thomas Tizard, C.B., A.F.C., F.R.S., has been appointed by His Majesty the King in Council to be Secretary to the Committee of the Privy Council for Scientific and Industrial Research on the retirement of Sir H. Frank Heath, K.C.B., from that office on 1st June next.

Mr. Tizard, who is a Fellow of the Royal Society, has done much research work on internal combustion engines, and during the war he was associated with the technical side of the Air Ministry, where he devised new methods of testing the performances of aeroplanes and their utility for different purposes. In his present position under the Department of Scientific and Industrial Research he has taken a very sympathetic interest in the work of the Illumination Research Committee, and we extend to him congratulations on his new appointment.

Street Lighting

The problem of street lighting figured largely in the two papers recently read before the Institution of Electrical Engineers by Messrs. Haydn T. Harrison and J. W. T. Walsh. It may, therefore, be of interest to draw attention to a useful series of contributions in *The Electrical Journal* (U.S.A.).* Mr. L. A. S. Wood deals with the Appraisal of Street Lighting, Mr. T. W. Rolph and others with the Directional Control of Light in illuminating streets, and other authors discuss such questions as control, planning ahead, finance, and sales efforts in connection with public lighting. There is also an account by Mr. J. C. Hail of the St. Louis Lighting Installation, on which eight million dollars is being expended. The belief is expressed that the recent advance in the standard of domestic lighting will be paralleled by similar progress in the lighting of streets. Examples recently quoted certainly suggest increased willingness on the part of many American cities to expend money in this direction. Ultimately progress depends on the ratepayers, who should be educated to take a civic pride in the proper lighting of the streets in their city.

* February, 1927.



Edison an Octogenarian

Readers will join us in extending congratulations to Mr. Edison, who was born in 1847, and has just recently joined the ranks of octogenarians. He is a standing example of the fact that a life of ceaseless and indefatigable labour is not necessarily opposed to longevity. Besides his invention of the electric incandescent lamp, Edison's numerous other activities have rendered his name a household word. *The Electrical World*, surveying the list of distinguished men who have attained the age of four score years, finds only one name of an American citizen that is equally familiar, i.e., that of Mr. John D. Rockefeller, whose great wealth and vast commercial enterprises put him in a class of his own.

Artificial Light and Horticulture

SOME INTERESTING EXPERIMENTS IN SWEDEN.

The experiments recently made in this country and the United States on the relation between artificial illumination and horticulture lend interest to some researches recently made in Upsala (Sweden), which are summarized in *Licht und Lampe*. A large greenhouse was divided into two sections. One half was exposed to daylight; the other was completely covered in with good heat-insulating material, and illuminated continuously by electric gasfilled lamps, an illumination of about 15 to 30 foot-candles being provided. Both sections were heated electrically. The results confirm those obtained elsewhere. The foliage of the plants grown under continuous artificial light was darker, and the development was hastened. Hyacinths, for instance, could be forced into bloom in five days, as compared with nine days in the part of the greenhouse receiving only daylight. An important conclusion from these experiments, which is not always sufficiently appreciated, is the possible saving in the cost of heating when the space is protected by insulating material instead of glass; it is believed that this saving (about 70 per cent.) will go far towards counterbalancing the cost of the artificial light. The note is illustrated by some data on the degree of illumination received during the year in Stockholm, Kolberg and Davos. This shows very clearly the low daylight illumination received in northern latitudes during the winter months—which renders the possibilities of artificial light specially promising in such localities.

The Tax on Luminous Signs in France

This country has fortunately so far been free from special taxes on lamps, signs, etc., such as have been introduced abroad. In France, for some years, taxes have been levied on luminous signs, and methods of using light for purposes of publicity; and there is a general feeling amongst those interested that they form an excessive burden. A demand for their revision has recently been presented by a syndicate of associations interested in electrical supply, lamps, signs, advertising and publicity, etc.

Lighting Progress in Europe

Interesting comparisons between progress in lighting and electrical development were drawn at the first meeting of the International Union of Producers and Distributors of Electrical Energy, held in Rome last autumn. In Italy the consumption of energy for lighting increased during the year by 16 per cent., as compared with 9 per cent. in the case of the United States. Similar data are reported for France, where the increase was about 13 per cent. for the year 1925. It is pointed out, however, that the consumption of electricity per capita is only 17 kw.-hours in Italy, as compared with 85 kw.-hours in the United States. As it is believed that the consumption for lighting in the United States is still only about half what it might be, it is pointed out that lighting in Italy is only one-tenth developed. In France, similarly, the consumption per capita for lighting is only 32 kw.-hours, so that here, too, there is still scope for increase.

Reflected Light as a Test of Polish

An ingenious application of light to test the perfection of polished surfaces was recently reported in *The Utility Bulletin*, and is mentioned in the *Transactions* of the American Illuminating Engineering Society (February, 1927). The intensity of light reflected from a metal surface is directly proportional to the degree of polish. Such reflected light can be readily measured with a photo-electric cell, and the idea has recently been applied to the testing of automobile parts. The cell is connected to an amplifying device and a milliammeter, the deflection of which can be taken as a measure of the light reflected. A high polish reflects light strongly, whilst a less perfect finish, which is accompanied by minute scratches which diffuse the light, diminishes the indication of the instrument. Accordingly specimens which fail to give a certain reading are discarded. The method is stated to be very sensitive—the existence of cracks so slight that they cannot be detected with a microscope being clearly indicated.

A Striking Luminous Sign in Vienna

An effective luminous sign, recently installed in Vienna, is described in *Die Lichttechnik*. It consists of a letter sign composed of electric lamps mounted on a tower, which carries a searchlight at its summit. The tower is 15.4 metres high and is erected on the top of the fourth story of the building, which is itself 21 metres above the street level. The sign utilizes 1,319 glow lamps which are run in parallel on 220 volts. The searchlight is stated to yield 27 million candle-power and is capable of rotation about a vertical axis. The general effect of the whole, seen from a distance, is stated to be very striking.

The "Osram-Lichthaus": Two Years Jubilee

On January 29th, the Osram-Lichthaus in Berlin completed its second year of existence, during which time much effective propaganda and demonstration work has been done. It is estimated that more than 40,000 people have visited demonstrations or taken part in discussions, etc.—an average of 56 persons a day!

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Artificial Light as an Aid to Aerial Navigation

(Proceedings at the Meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 6-30 p.m., on Tuesday, February 22nd, 1927.

A MEETING of the Illuminating Engineering Society was held at the House of the Royal Society of Arts (18, John Street, Adelphi, London, W.C.), at 6-30 p.m., on February 22nd, Mr. J. W. T. WALSH presiding.

The minutes of the last meeting having been taken as read, the Hon. Secretary presented the names of the following applicants for membership: —

Members:—

Brighty, A. W. S. ....Lighting Engineer, Port Holme, 2, South View Gardens, Wallington, Surrey.

Edwards, E. A. .....Electrical Engineer, Messrs. Pooley & Austin, 34, Broadway, Westminster, S.W.1.

English, S. .....Illuminating Engineering Department, Holophane Ltd., Elverton Street, Westminster, S.W.1.

Williams, R. G. .....Illuminating Engineering Department, Holophane Ltd., Elverton Street, Westminster.

The names of applicants presented at the last meeting* were read again, and these gentlemen were formally declared members of the Society.

The CHAIRMAN then called upon Mr. H. N. GREEN (Royal Aircraft Establishment, Farnborough) to read his paper entitled "Artificial Light as an Aid to Aerial Navigation," which was as follows: —

Artificial Light as an Aid to Aerial Navigation

By H. N. GREEN

(Royal Aircraft Establishment, Farnborough)

Introduction.—It is now just about five years since this subject was dealt with in a paper entitled "The Use of Light as an Aid to Aerial Navigation," by Lieut.-Col. Blandy, D.S.O. This meeting proved to be of great interest, and it has been suggested that an account of some of the developments that have since taken place might be of value.

Light, as an aid to aerial navigation, is used in such a variety of ways that it would take too long to describe every application in detail in a single paper. My remarks to-night will, therefore, be confined to beacons and the lighting units used on aerodromes, without reference to the navigation and other lights carried on the aeroplane.

I was influenced in my choice of subjects by the fact that during the last three or four years the design of beacons and aerodrome lighting equipment generally has undergone so many improvements. The rapidity of this development indicates that we are still far from reaching finality, and it is hoped that a brief explanation of the difficulties to be overcome and the essential conditions to be complied with will lead to a useful discussion. I have been allowed considerable latitude by the Air Ministry in the preparation of this paper, and the opinions expressed are therefore not necessarily those held officially.

Location of Beacons.—When considering the arrangement and type of beacons for the marking of an air route, one is struck by the number of alternative methods which can be employed and by the varying conditions for which allowance must be made. A number of high-power beacons can be used spaced a considerable distance apart, or low-power beacons placed closer together; a beacon can be made recognizable as such amongst other lights by imparting a characteristic colour to the beam or by causing it to flash at known intervals; while a design which would be efficient in very clear weather might be useless in mist. It may be stated before going any further that a beacon cannot be made which will be equally efficient in all types of weather; the most we can hope for is to evolve a design to have the best possible efficiency for the average weather conditions which obtain in the locality where it will be used.

Taking first the question of the choice of positions for aerial beacons, the general rule is that, under average conditions of visibility, as soon as the aeroplane passes over a beacon the pilot should be able to see the next light on the route. It has been suggested that it is preferable to adopt a staggered arrangement of beacons along the route on the ground that there is thus a better chance for a pilot who has strayed off the course to pick up a light and correct his bearings accordingly.

In the selection of the actual site a knowledge of the local weather conditions is helpful, particularly as regards the frequency of occurrence of mist and fog. A beacon is defined in the dictionary as "a fire lighted on a hill," but experience in this country has shown that the summit of a hill is not necessarily an ideal position. During the night high ground is often capped by clouds and mist, while the low-lying country is comparatively clear. Conversely, and more frequently, the low ground may be misty and the high ground clear. It appears that it is preferable to choose a site slightly above the average level of the surrounding country, and to mount the beacon on a tower of sufficient height to clear ground mists. The position chosen should be as free as possible from other lights liable to cause confusion.

The desirable qualities of an aerial beacon are, in order of importance:

(*a*) The light should have a distinctive character enabling it to be easily distinguished from other lights.

(*b*) It should be reliable in operation and require little attention.

* *The Illuminating Engineer*, February, 1927, p. 37.

(*c*) The range within which the beacon is visible should be a maximum for a given energy consumption, while the light distribution should be such that sudden changes in apparent luminous intensity are avoided when approaching from a distance.

Character of Light.—I will deal with these points in the order in which they have been raised. The necessity for a light of distinctive character can best be realized by a comparison between the services required from an aerial beacon and from a marine lighthouse.

The conditions under which a marine lighthouse is observed are usually as follows: An important lighthouse will always be very much more powerful than any neighbouring lights, and therefore becomes visible as an isolated point of light on the horizon long before any other confusing lights are seen. The observer knows approximately when and where to look; he is armed with a telescope, and if in doubt about the timing of the flashes constituting the signal he uses a stop-watch.

The pilot of a modern commercial aeroplane has approximately 20 different things requiring regular attention. He is constantly exposed to a wind of from 60 to 100 miles per hour, and occasionally has to make his observations through wet goggles. Flying at a height of 5,000 feet his horizon is approximately 90 miles away, so that by looking sideways and ahead he can see 12,700 square miles of country. It needs very little imagination to picture the number of lights which can be seen simultaneously on a clear dark night. Some of these lights, such as street lamps, are steady; others send up intense flashes which can easily be mistaken for the beam from a flashing beacon. (Motor-car headlights are the worst offenders in this respect.) It will be realized that, under the conditions described, to pick out any given light is a matter of some difficulty unless it has a very definite and marked character.

A light can be given character by causing it to flash repeatedly at definite intervals. A single flash occurring at, say, 5-second intervals, would not be easy to recognize, as it could be confused with other isolated flashes due to road traffic headlights, etc.; a beacon should, therefore, always be made to send out at least two flashes separated by an interval of darkness longer than that which separates the flashes themselves.

This result can be achieved in a number of different ways, the most direct method being to light and extinguish the source.

High candle-power gasfilled lamps, such as would be ordinarily employed in beacons, are not satisfactory when flashed in this way, as, owing to the thermal inertia of the filament, the rate of incandescence and nigrescence is slow.

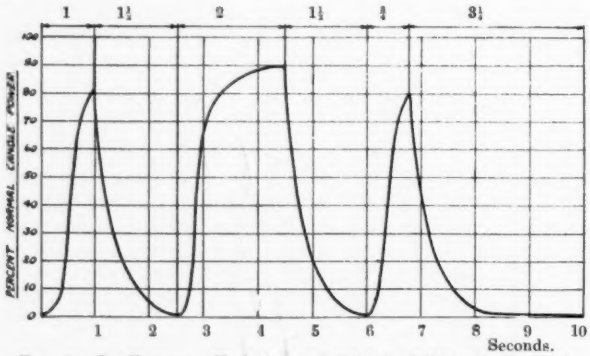


FIG. 1.—Candle-power Variations of 100-volt 1,500-watt Gasfilled Lamp when used to flash the letter "R" (- — -).

Fig. 1 shows the instantaneous values of the candle-power obtained from a 100-volt 1,500-watt gasfilled projector lamp when used to flash the letter R (in Morse • — •).

It will be seen that the signal consists of alternations of bright and dull incandescence rather than clear-cut flashes, and that the lamp never has time to reach its full candle-power.

The total time of 10 seconds which was allowed for the group of flashes and the interval separating it from the transmission of the next group was found, by observation from the air, to be the minimum required to give a reasonably sharply defined character.

Electric incandescent lamps must be flashed so slowly, if a blurred signal is to be avoided, that the signal becomes inconveniently long and takes up too much of the pilot's time to identify. The pilot has other matters to attend to, and it is now generally accepted that the period required for reading a light should never exceed 10 seconds. Preferably it should be very much less.

As the 1,500-watt lamp, of which the performance curve is shown in Fig. 1, takes the full 10 seconds to flash the letter R (• — •), it obviously cannot be used for any letters of which the Morse equivalent is longer than two dots and a dash. For this reason, coupled with the fact that the signal is always more or less blurred, flashing incandescent lamps have a limited sphere of usefulness.

The use of shutters rotating round the lamp offers another alternative, but has not been widely adopted, as the mechanism required is too complicated for unattended lights.

To obtain a flashing character the apparatus most commonly used is a group flashing lens, of which a typical example is shown in Fig. 2.

This particular lens is made up of three lenses, having a common focal point and the axes set at a slight angle to each other. The complete optical system rotates slowly round the light source, sending out three beams which sweep round the horizon. The light would be observed as three rapid flashes succeeded by a longer interval of darkness.

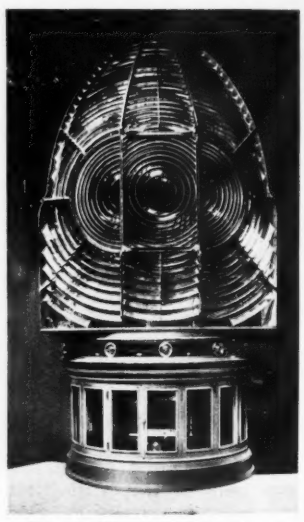


FIG. 2.—Group Flashing Lens.

By means of a group flashing lens a character can be exhibited consisting of two, three, four or more flashes of equal length. It is not, however, possible, with standard lenses, to produce flashes of varying length such as are required to send a flashing signal in Morse—the number of characters which can be shown is, therefore, limited.

Coloured light, as a means of obtaining character, has perhaps not yet received the attention it deserves. The delay in development is chiefly due to the relatively low-power light sources available for use in unattended beacons, coupled with the heavy absorption losses which occur when filters are used to impart colour to the beam.

The strontium beacon, invented by Mr. Toulmin Smith and Capt. Davis, represents an attack on the problem from another angle, as screens were dispensed with and colour imparted to the light itself. The source used was an oxy-acetylene flame having a thin endless chain running through it continuously. This chain also passed through a bath containing a solution of strontium chloride, and the solution was thus carried into the flame, which assumed the bright orange colour characteristic of strontium. The flame, having a small area, was well adapted for use with an optical system, and the beacon shown on the screen was made up for experimental purposes. A 36 in. searchlight was used, and the flame focussed so that a parallel beam was formed. This beam was split by means of inclined mirrors into two separate beams at 180° and spread vertically to give the correct light distribution. The strontium beacon gave promising results in the experimental stage, both as regards range and character, but work on it was suspended as the neon light, which is available in a commercial form, was ready to meet immediate requirements.

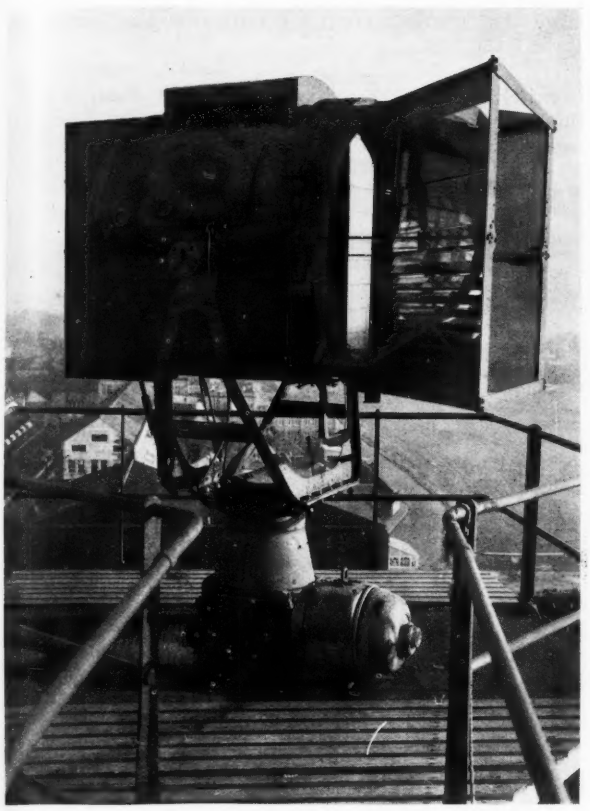


FIG. 3.—Strontium Beacon.

The neon beacon, to which I will refer in greater detail later, emits a red light of unmistakable colour, has an easily recognizable shape, can be flashed with great rapidity and, owing to the fact that neon tubes cannot be conveniently used with a lens or reflector, has an extremely low luminous efficiency.

Perhaps the latter part of this statement needs amplification. The luminous efficiency of a neon beacon, measured in the direction of maximum intensity, is approximately 1.5 candles per watt. With a lens 3 ft. in diameter and a source of high intrinsic brilliancy, it is possible to attain an "efficiency" of 10,000 candles per watt in the beam.

I think these figures, and the fact that most pilots prefer the neon beacon to all others, are a striking tribute to the importance of character in a light.

Illuminants.—Dissolved acetylene gas lends itself readily to the requirements of unattended beacons. The development of automatic gas burners in connection with marine lights has been proceeding for many years, and the apparatus available sets a very high standard, both as regards reliability and easy maintenance.

It is almost true to say that the length of time a gas beacon will operate without human attention depends on the amount of gas provided for it to burn.

A gas beacon is fully automatic in the sense that it will change the mantle in case of failure, rotate the lens in the case of a revolving light, light up at dusk and go out at dawn.

There is no reason why electricity should not be made to do everything that gas does, possibly not so economically or reliably at first, but with the great advantage that, using a gasfilled lamp, a light source would be available having an intrinsic brilliancy of 3,500 candle-power per square inch in place of the 250 candle-power per square inch given by an incandescent acetylene gas mantle. This is a matter of the utmost importance, as the beam candle-power obtainable is, in all types of lenses used for aerial beacons, directly proportional to the intrinsic brilliancy of the light source.

Light Distribution.—The light distribution which is given to a beacon is at best an approximation to suit average conditions. An ideal light distribution could only be worked out if the weather never changed and aeroplanes always flew at the same height.

It has been shown by Paterson and Dudding* that the visibility of a point source is proportional to

(i) The total candle-power of the source, and is independent of intrinsic brilliancy.

(ii) The inverse square of the distance.

Within the ranges at which a beacon is useful it can be treated as a point source and the light distribution determined in accordance with these laws. As, however, the ranges we are considering may be anything up to 100 miles, allowance must be made for atmospheric absorption of light.

If I is the candle-power of the main beam from a beacon

t the percentage of light transmitted through unit distance of atmosphere

d the range required

V the degree of visibility required,

then $$V = \frac{I t^d}{d^2}$$

and $$I = \frac{V d^2}{t^d} \quad . \quad . \quad . \quad . \quad . \quad . \quad (i)$$

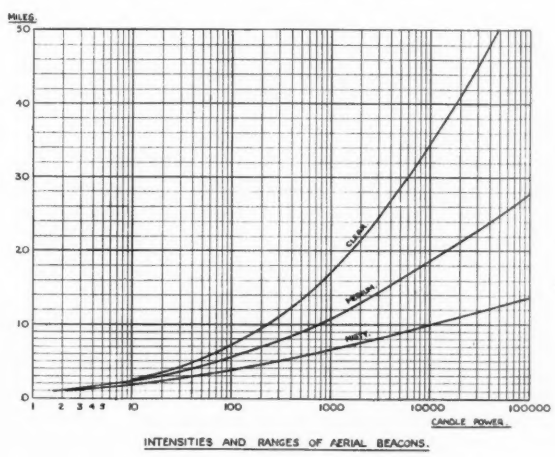
The beam candle-power required to obtain a given range can thus be calculated once values have been assigned to V and t.

A value for V (the minimum intensity which can be considered visible at unit distance) has been determined, in clear air for a distance of one nautical mile, by Paterson and Dudding as 0.41 candle-power and by the Deutsche Seewarde as 0.47 candle-power.

From these figures a light having an intensity of 0.3 candle-power would be just visible in clear air at a distance of one statute mile. For reasons already given it would be impossible to recognize from the air with any degree of certainty a light source having this degree of visibility.

It was, therefore, necessary that an arbitrary standard of visibility should be adopted for aerial beacons, and a provisional figure of 1.5 candle-power at one mile was decided on. We have not yet collected sufficient data to be able to say whether this figure requires modification either way, but our experience so far indicates that no great change will be required.

The percentage of light transmitted through unit distance of air, t, must generally, in the absence of data, be given an assumed value. French experimenters have determined t, for one kilometre of atmosphere on a clear night, as 0.973, so that the absorption of one mile of air may be anything between about 5 per cent. in very clear weather to 100 per cent. in fog.



INTENSITIES AND RANGES OF AERIAL BEACONS.

FIG. 4.

It has been suggested that at high altitudes atmospheric absorption decreases considerably, and that this effect is of sufficient importance to be taken into consideration when determining the light distribution of beacons. The low absorption at high altitudes may be expected to increase the range of very powerful beacons, but in the case of medium-power beacons, say up to 100,000 candle-power, the effect is almost negligible.

* Proceedings Phys. Soc., Vol. XXIV, Part VI, p. 379.

To enable the range from the air for a beacon of given candle-power to be readily ascertained, I have calculated range curves based on a visibility of 1.5 candle-power at one mile and on a transmission coefficient of 0.95 per mile for clear weather, 0.85 for medium weather, and 0.65 for misty weather.

To enable the very high candle-powers necessary for long ranges to be shown, the intensities are plotted to a logarithmic scale.

INTENSITIES AND RANGES—AERIAL BEACONS.

Range in miles	Candle-power visible. (V = 1.5.) Clear weather. t = 0.95	Medium weather. t = 0.85	Misty weather. t = 0.65
1	1.5	1.67	2.2
2	6.3	7.9	13.5
3	14.9	20.9	45.7
4	28	43.5	128
5	46	80.2	307
6	70	136	676
7	100	218	1,425
8	137	335	2,850
9	183	548	5,550
10	238	792	10,630
11	304	1,030	19,700
12	380	1,442	36,100
13	467	1,980	65,200
14	572	2,710	116,000
15	690	3,660	205,000
16	830	4,910	362,000
18	1,160	8,610	1,075,000
20	1,590	14,700	3,150,000
22	2,138	24,600	9,000,000
24	2,810	40,600	25,300,000
26	3,650	66,100	70,000,000
28	4,690	101,000	193,000,000
30	5,970	168,000	
32	7,530	270,000	
34	9,470	411,000	
36	11,700	638,000	
38	14,500	998,000	
40	17,800	1,520,000	
50	46,900	12,050,000	

In designing an aerial beacon the first step is to decide on the range required, and to find from the curves or from equation (i) the candle-power required in the main beam.

The angle of elevation (θ) of the main beam is then fixed to suit the average height (h) at which machines using the route will fly.

$$\theta = \sin^{-1}\frac{h}{d} \quad . \quad . \quad . \quad . \quad . \quad \text{(ii)}$$

After the pilot has entered the beam, and is flying towards the beacon, the light should remain continuously in view. Its visibility should theoretically remain constant, but in practice it is usual to allow an increasing visibility as the beacon is approached, thus making partial allowance for bad weather conditions.

The intensity which should be emitted at any angle (α) between the main beam and zenith for constant visibility is given by

$$I_\alpha = \frac{V h^2 \operatorname{cosec}^2 \alpha}{t^{h \operatorname{cosec} \alpha}} \quad . \quad . \quad . \quad \text{(iii)}$$

In equation (ii), for the beam angle, the effect of atmospheric refraction is not allowed for. The main beam from a beacon will usually be directed two or three degrees above the horizontal, and will pass through strata of air of diminishing density and refractive index, so that there will be a tendency for the beam to be deflected downwards.

We have little information to enable corrections for this effect to be made, and, in view of the fact that the amount of refraction is very variable, it appears that any allowance which is made in beam elevation must be based on experience rather than on calculation.

The extra elevation of the beam to allow for refraction at a range of 100 miles is approximately 0° 40′ in clear weather. When dealing with medium-power beacons it will usually be found that the angle of divergence of the main beam, due to the size of the light source, is so large that the correction for refraction may safely be neglected.

Optical Systems.—The lenses used in beacons are divided into orders according to their focal length, ranging from a sixth order with a focal length of 5.9 inches to a hyper-radial lens having a focal length of 52.36 inches. There are two main types of lenses, fixed and revolving.

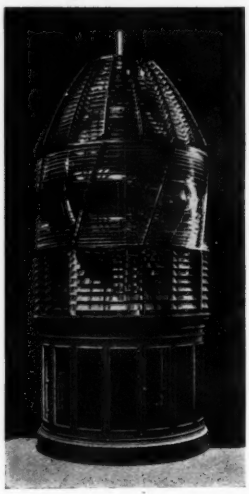


FIG. 5.—First Order Fixed Lens.

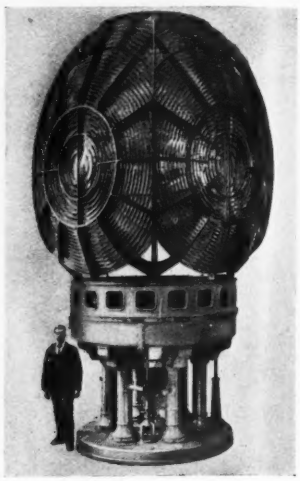


FIG. 6.—Hyper-radial Lens.

The fixed lens sends out a beam of narrow vertical divergence through a horizontal angle of 360°, and consists of cylindrical prisms mounted about a vertical axis. The centre lens belt and prisms redirect the light by refraction and from the dioptric portion of the optic, the upper and lower sets of prisms are catadioptric, acting by a combination of reflection and refraction. For any given light source the beam candle-power obtained is directly proportional to the focal length of the lens employed.

Revolving lenses, which are essentially large circular lenses stepped to avoid an inconvenient thickness of glass, concentrate the light in a beam of very small divergence, and can be made to give enormous beam intensities. Fig. 6 shows a hyper-radial lens designed for a marine lighthouse. The lens, with mounting, weighs six tons and the beam intensity is 1½ million candles.

Beam Candle-power.—It may be of interest to give briefly the method of calculating the candle-power along the axes of revolving and drum lenses. The equations for the revolving lens are identical with those given by Benford* for the parabolic mirror. They are, however, repeated in order to simplify the explanation of the characteristics of the fixed lens.

Considering, first, the case of a revolving lens, it is assumed that the light source used is spherical in shape, and that it emits an equal light intensity in all directions. The intrinsic brilliancy of the light source is denoted by B, the percentage transmission of the lens by m, the radius of the spherical source by r, and the radius of the lens by R.

When the lens is observed at close range only the centre will appear bright, but on moving further away along the axis the luminous disc expands till finally, at a distance L, it fills the whole lens. At this point

$$I_b = \pi R^2 m B \quad . \quad . \quad . \quad . \quad \text{(iv)}$$

that is, the area of the lens multiplied by its intrinsic brilliancy m B. From L onward the inverse square law takes effect, and the candle-power is constant.

The assumption that the law of inverse squares can be applied at distances greater than L only holds good if R is very small compared with L. When this is so

* Frank A. Benford, Jr., "The Parabolic Mirror." *Trans.* I.E.S. (America), Vol. X., page 905.

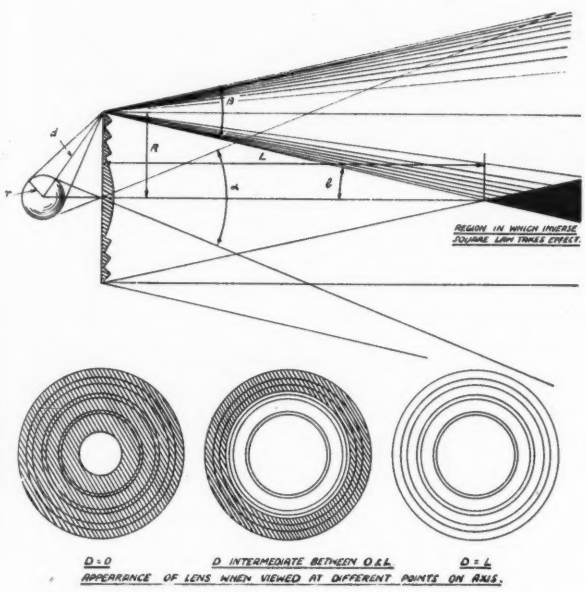

REGION IN WHICH INVERSE SQUARE LAW TAKES EFFECT.
D = 0
D INTERMEDIATE BETWEEN O & L
D = L
APPEARANCE OF LENS WHEN VIEWED AT DIFFERENT POINTS ON AXIS.

FIG. 7.—Beam Characteristics of Lens with Spherical Source.

the beam, which is made up of a number of beams having different angles of divergence, may be considered as emanating from a point on the lens surface, and the normal illumination at any distance (D) along the axis and beyond L is given by

$$E = \frac{\pi R^2 m B}{D^2}$$

The distance L depends on the relative diameters of the source and lens. Light emerging from the centre of the lens will have the largest angle of divergence (α) and will fill the whole beam; light from the edge of the lens will have a smaller angle of divergence (β). The lens will not appear luminous all over till the point L on the axis is reached, where the boundaries of the cones of light from the edge of the lens cuts the axis.

The angle b, which the boundaries of the cones make with the axis, may be found from

$$b = \sin^{-1} \frac{r}{d} \quad . \quad . \quad . \quad . \quad (v.)$$

where d is the distance from the focus to the edge of the lens. The distance L where these boundaries cross the axis is

$$L = \frac{R}{12} \cot b \quad . \quad . \quad . \quad . \quad (vi.)$$

where L is in feet and R in inches.

In practice, L may be anything from a few feet to several hundred yards, so that serious errors may easily occur in measurements of candle-power unless a preliminary idea has been formed of the beam characteristics.

An expression for the candle-power along the axis of a fixed lens has been obtained by a similar process of reasoning to that followed for the revolving lens.

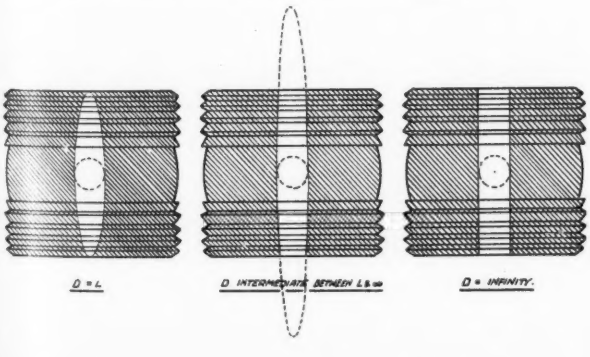


FIG. 8.—Shape of the Luminous Area on a Drum Lens with Spherical Light Source.

The light source is assumed to be spherical, and the appearance of the lens is again observed at different distances along the axis. (See Fig. 8.)

When looked at through the glass close to the lens the light source is again seen as a luminous disc. Moving away along the axis of the lens the disc does not appear to expand in diameter, as in the previous case, but the width of the disc remains constant while it lengthens upwards and downwards, forming an ellipse. (Strictly the shape of the luminous area is not perfectly elliptical, but the approximation is sufficiently accurate for all practical purposes.)

At a distance L (given by equation vi) the major axis of the ellipse is the same as the height of the lens.

The beam candle-power can therefore be determined at distance L as follows:—

$$I_b = I_s m \times \frac{\text{area of luminous ellipse on lens}}{\text{plane area of a great section of source.}}$$

The area of an ellipse is given by π TC, where

$$T = \text{semi-transverse axis} = \frac{H}{2}$$

$$C = \text{semi-conjugate axis} = r$$

Therefore

$$I_b = \frac{I_s m \pi H r}{2 \pi r^2.}$$

$$= \frac{I_s m H}{2r}$$

If the width of the source is denoted by W,

$$I_b = I_s m \frac{H}{W} \quad . \quad . \quad . \quad . \quad (vii)$$

Continuing to recede from the lens the ellipse continues to lengthen, only part of it remaining on the lens, till at an infinite distance the shape of the luminous area is a rectangle.

The candle-power is then given by

$$I_b = \frac{I_s m}{\pi r^2} \times 2r H$$

$$= I_s m \frac{H}{W} \times \frac{4}{\pi} \quad . \quad . \quad . \quad (viii)$$

It will be noted that the apparent candle-power of a drum lens continues to increase till an infinite distance is reached.

In certain cases, if the candle-power is measured at distance L and multiplied by 1.27, that is $\frac{4}{\pi}$, a good idea can be obtained of the effective candle-power of the lens at long ranges.

Equation (viii), written in full, has a definite meaning since $\frac{I_s m}{\pi r^2}$ is the intrinsic brilliancy of the luminous area on the lens, and $2r H = W H$ is the area of the luminous surface of the lens. Equation (viii) may, therefore, be rewritten in a simplified form:—

$$I_b = B m H W. \quad . \quad . \quad . \quad . \quad (ix)$$

It will be seen that the width and intrinsic brilliancy only of the light source affect the axial candle-power obtainable from a fixed lens. The height of the source does not enter into the equation.

Although it has been assumed up to the present that the source employed is spherical, a little consideration will show that an equal axial intensity would be obtained by substituting a disc source of equal diameter for the spherical source.

The disc would be placed horizontally with its centre at the focus of the lens.

(To be continued.)

Visit of Members of the Illuminating Engineering Society to the G.E.C. Research Laboratories, at Wembley, March 8th, 1927

A TOUR of the Laboratories.—Members of the Illuminating Engineering Society paid a visit to the G.E.C. Research Laboratories at Wembley on March 8th. On arrival at 3 p.m. the party was welcomed by the Director, Mr. C. C. Paterson, and other members of the staff, and about an hour and a half was spent in going through the various laboratories, special attention being paid to those concerned with the testing of lamps and photometry. In the subsequent two pages (pp. 107, 108) an account is given of some of the chief features in this respect. Visitors were much impressed by the extent of the space available, and the orderly manner in which it is utilized to the best advantage. In addition to the special equipment of pipes carrying water and various gases useful for experimental work, the arrangement of mains carrying direct and alternating current is unique, the whole series being carried overhead through a gallery and taken down to rooms wherever required. An important feature is the miniature lamp factory where a few specimens of any new type of lamp can be made, and the effect of small modifications tested before the process is embodied in the factory routine. Equally interesting were the wood and metal workshops, in which practically any piece of apparatus or furniture required can be made on the spot. We noticed a large model of a spherical integrating photometer in course of completion. In the rooms devoted to the preparation of filaments and the microscopical examination of their structure, much interesting apparatus is to be seen; likewise in connection with the testing of large power-valves for which special h.t. arrangements are made. We were particularly interested in the interlocking methods for safeguarding operators using apparatus in high-tension chambers, and in the luminous signalling arrangement whereby it is automatically shown which chambers are in action.

Discussion on the Street Lighting Specification.—After an interval for tea, the party next assembled in the handsome library. Here a general meeting of the Society, presided over by LT.-COL. KENELM EDGCUMBE, took place.

After the minutes of the last meeting had been taken as read the names of applicants for membership presented at the last meeting* were read again, and these gentlemen were formally declared members of the Society.

The Chairman then called upon Mr. C. C. PATERSON, Chairman of the Committee, to open the discussion on the Standard Specification for Street Lighting, drafted by the B.E.S. Sub-committee. Mr. C. C. Paterson recalled the well-known paper read before the Illuminating Engineering Society by Mr. A. P. Trotter in 1913. Since that date the subject has been closely studied, but street lighting is still in course of development. Therefore, it had seemed expedient to draft the specification on broad lines. Mr. Paterson then proceeded to explain the chief clauses. Streets are grouped in seven classes, graded to receive min., mid-span, horizontal illuminations of from 0.02 (G) up to 2 foot-candles (A). A corresponding table of minimum heights for each class should assist in limiting glare, which is also dealt with in a clause requiring that "installations should be free from objectionable glare." In the appendix a process is outlined for determining the "glare factor" based on the method suggested by Mr. J.T. Walsh and developed by Mr. J. M. Waldram. Other clauses relate to the method of testing. The actual illumination in practice should not be less than half the value originally specified for the new installation. It is also specified that posts should not be further apart than 12 times their height. The specification is only regarded as a first step, but it was felt that its adoption could not fail to advance the art of street lighting in this country. In conclusion, Mr. Paterson, on behalf of his colleagues, expressed their acknowledgment of the assistance derived from many quarters, including the paper read by Mr. Trotter in 1913.

The discussion was continued by Mr. J. M. WALDRAM, who gave an account of the method adopted in dealing with glare. Others who took part included CAPT. W. J. LIBERTY, Mr. W. J. JONES, Mr. A. CUNNINGTON, Mr. W. S. STILES, Mr. J. S. DOW, Mr. T. E. RITCHIE, Dr. ENGLISH, Mr. MORTON, Mr. A. BLOK, Mr. A. C. JOLLEY and the CHAIRMAN (Lt.-Col. Kenelm Edgcumbe). CAPT. W. J. LIBERTY also presented a letter from Mr. COLQUHOUN (Lighting Engineer of Sheffield) dealing with a number of practical points in the interpretation of the specification.

General agreement with the aims of the specification was expressed by those present, but a number of interesting points were raised. It was suggested that in the preface to the specification some reference should be made to the specification drafted by the joint committee representing the Illuminating Engineering Society, the Institutions of Gas and Electrical Engineers and the Institution of Municipal and County Engineers, which was presented in Mr. Trotter's paper in 1913. The proposed series of heights for the various classes were approved, though the method of determining the "glare factor" raised some discussion. Some speakers recalled the objection taken in 1913 to a system of grading based on minimum illumination alone, whilst others suggested that the diversity-ratio should be limited.

It was also suggested that the phrase "reasonably graded" applying to the distribution of illumination between maximum and minimum was not sufficiently explicit, and attention was drawn to the desirability of lamps at standard rating being used in the fittings; otherwise abnormal results might be obtained with over-run lamps. A desire was also expressed that the classification of roads should be dealt with as soon as possible, in order that the specification might also furnish a guide to the requirements of different classes of streets.

Mr. C. C. PATERSON briefly replied to some of the chief points raised in the discussion, which it was agreed had been extremely informative and would doubtless be of service to the Committee.

In conclusion, a vote of thanks to Mr. Paterson for introducing the discussion, to Lt.-Col. Edgcumbe for presiding, and to the G.E.C. for their hospitality was moved by Mr. Gaster, seconded by Capt. Liberty, and carried with acclamation. Mr. Gaster remarked that it had been a great pleasure to members to see over the laboratories, the existence of which was an indication of the foresight of the Company. He felt sure that their enterprise in this respect had been well repaid, and there could be no question of the great practical value of the work done by Mr. Paterson and his staff.

(A fuller account of the discussion on the Street Lighting Specification will appear in our next issue.—Ed.)

* See p. 101, in this issue.

The Lamp and Illumination Sections of the Research Laboratories of the General Electric Company, Wembley

A CONSIDERABLE part of the Research Laboratories at Wembley is devoted to investigations on the development, manufacture, use and testing of electric lamps and on their performance in fittings. Three rooms are devoted entirely to photometry and problems of illumination, and, in addition, there are four experimental development laboratories for the preparation of tungsten wire and the study of evacuation and similar problems, in which processes may be carried out on a commercial scale, and in which experimental wires or lamps may be made up. There is also one of the largest equipments in the country for the life testing of lamps. The equipment in each of these branches will be described.

The portion of the laboratory of most interest to illuminating engineers is that devoted to illumination (Fig. 1), in which the problems considered relate to the design and performance of complete lighting units rather than to the photometry of standard lamps. It includes apparatus for the study of polar distribution, consisting of the usual rotating mirrors and photometer bench. The two-mirror system is used, having provision for reading either on a straightforward angular scale or in 10 or 20 zones of Russell angles; the mirrors can be seen on the left of Fig. 1. The photometer bench used as

FIG. 1.—A portion of the Laboratory devoted to Illumination.

the distribution photometer on the right of the photograph is capable of being moved along its own axis in rails in the floor so as to give a considerable possible variation of distance between the fitting or lamp under test and the photometer head which is kept fixed at one end of the bench. A scale of metres is provided on the floor with an index on the bench. Should it be necessary, on account of high luminous intensity, the photometer head may be removed to as far as 20 metres away by running the whole bench into the next laboratory.

The photometer benches were designed and made at the laboratories and are of a somewhat unusual pattern. The framework of the bench consists of a stiff wooden box girder supported on wheels at either end at a height of approximately one metre from the floor. The box contains the leads for the various electric supplies. Two horizontal rails are arranged vertically above one another on one side of the bench, on which the carriages run on ball bearing vee rollers, the motion being extremely easy. Each of the three carriages may be clamped either to the rails or to an endless wire running the length of the bench by which it may be moved; the control wheel may be placed in any position along the bench. The bench on the distribution photometer, however, is being replaced by a new photometer, seen next to the mirror gear in the photograph, in which the light is controlled by a stationary variable aperture sector; the photometer is conveniently arranged so that one observer may take all observations from a central position with considerable rapidity. Sufficient ranges are embodied to avoid the movement of the instrument even for very high intensities.

For the photometry and investigations of projectors and floodlights there is a runway on the ceiling supporting a screen, which may be placed at any position along the laboratory. Illumination measurements are made with a "Macbeth" illuminometer which has been altered to embody a Lummer-Brodhun contrast field. It is shown in the photograph in the foreground, used in connection with a small spherical integrator.

The largest of the integrating photometers is in the illumination laboratory. It consists of a cube of 6-ft. side, the corners being cut off to form a 14-sided enclosure. The photometric arrangements have been designed to occupy a minimum of space; the comparison lamp runs on a vertical slide in a tower, its position being varied by a handwheel. A scale attached to the comparison lamp is visible either through an opening in the wall of the tower, or by means of a periscope, according to the range employed, and indicates the flux emitted by the lamp under test directly in lumens. The cube photometers are designed primarily for lamp testing since a large number of lamps have to be tested daily under the life test system presently to be described. In the large integrator the lamps are run in from the side of the cube on two sliding arms so arranged that one lamp goes in as the other comes out. A change-over switch is automatically operated so that the meters and supply are transferred to the lamp in the cube. The integrator may also be used for finding the outputs of small fittings.

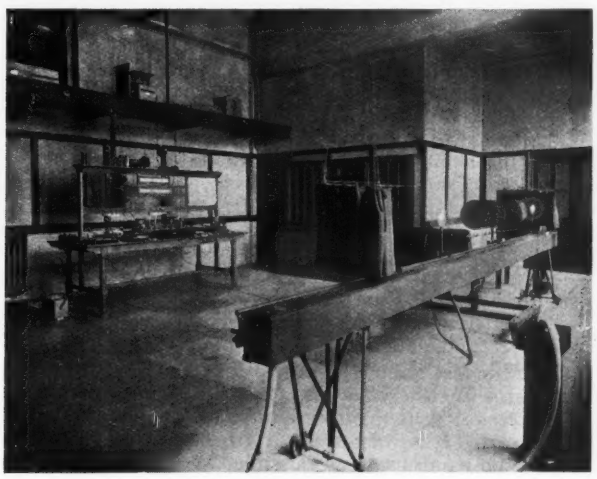


FIG. 2.—Standards Photometry Room.

In the standards photometry room, shown in Fig. 2, work of a more precise nature is carried out in the calibration and checking of standard and comparison lamps, and accurate measurements of luminous output. The photometric benches are of the same pattern as that in the illumination laboratory, but electrical measurements are made almost entirely by the potentiometer seen on the left of the photograph. For accurate photometry it is necessary to make electrical measurements accurate to one part in 10,000—a degree of precision for which indicating instruments are unsuitable.

The laboratories have recently produced standard lamps of the gasfilled pattern, at suitable ratings for ordinary bench work, which have not previously been obtainable, and which are of great assistance in bridging the gap between the colour of ordinary gasfilled lamps and that of the vacuum lamps previously used as standards. Considerable advances have been made in

the construction of gasfilled and vacuum lamps as standards both of directional and of mean spherical intensity. The filaments are spot welded at each support, and in the latest vacuum directional standards a spring is provided on each loop of the filament to take up sag due to expansion.

The life testing of lamps is carried out on a large scale, as will be realized from the fact that some 2,000 lamps are burned continually, night and day, absorbing 100-120 kw. The work is carried out on a regular routine. A selection is made at random from the Osram Lamp Works at Hammersmith from consignments of the requisite types, and two types of test are carried out: the rating test, made in order to determine whether the lamps lie within the limits prescribed by the B.E.S.A.

FIG. 3.—Showing Apparatus for Lamp Testing, including the new instrument developed for rating lamps by a photometric colour-matching method.

specification for voltage, wattage and luminous output; and the life test, to determine the duration of life of the lamps and their behaviour during life. For the photometric work, cubical integrators similar to that already described are employed, but on a smaller scale for the low-powered lamps. One of these may be seen in use on the left of Fig. 3. Lamps from 10-150 watts are photometered in integrators of 2-ft. side, and miniature lamps in an integrator of 1-ft. side. The corners of the cube are not cut off in these instruments. Larger lamps are photometered in the 6-ft. integrator already described. The 2-ft. integrators are exactly similar to the 6-ft. instrument, with the exception of the lamp-changing device which is pneumatically operated. On the right of Fig. 3 may be seen a new instrument which is being developed for accurately rating lamps by a photoelectric colour-matching method.

The life test room is seen in Fig. 4. The lamps to be tested for life are set up in racks of 10 lamps, each rack being operated at the appropriate voltage for the lamps concerned. It is very necessary that the voltage control should be as accurate as possible, and for this purpose the installation is fed from two 50-kva. 415-volt 50-cycle motor generator sets provided with Tirrill regulation to $\pm\frac{1}{4}$ per cent. The main life test is fed from this A.C. supply, but there are, in addition, two $2\frac{1}{2}$-kw. D.C. generators providing a 3-wire 150-volt D.C. supply for special tests. The racks are arranged in bays, each of which is fed from a tapped auto-transformer wired to switchboards with cord connection so that any voltage from 0 to 300 can be applied to any rack in steps of two volts, and a fine adjustment is provided by a series resistance. The exact voltage on each rack is measured by plugging in a voltmeter. Special racks are provided for motor car headlights, in which each rack of three lamps is fed from a small transformer, the primary of which is fed from the large tapped transformer—an arrangement necessitated by the relatively heavy currents and low voltages of these lamps.

The lamps on life test are photometered at definite intervals during life, and the results are carefully recorded. In addition to the routine life test there is, of course, the testing of experimental lamps, new wires, etc.

The lamp development laboratory is engaged in the production of experimental lamps and the making of standard lamps. The automatic machinery employed in the lamp works is unnecessary, so that most of the work is done by hand or on less complex machines.

In the tungsten wire development laboratory and the metallurgical laboratory the whole of the processes in the preparation of tungsten, from the ore to the finished

FIG. 4.—The Life Test Room.

spiral filament, are carried out for the purpose of developing new wires or of studying processes in manufacture. Space does not permit of a detailed description of the many additional activities of the laboratories in such directions as metallurgy, glass technology and refractories, etc.—all of which have a bearing upon the manufacture of electric lamps—nor of telephone repeaters, arc lamp carbons, primary batteries, domestic and industrial electric appliances and other products of the General Electric Company.

Precision Photometry in the Testing of Lamps

A very informative bulletin has been recently issued by the Bureau of Standards (Washington) describing the procedure adopted in testing lamps in accordance with the requirements of standard specifications. Recent alterations in the standard specification, whilst presenting considerable practical advantages, have added considerably to the amount of photometry to be done. Accordingly every effort has been made to lighten the labour.

There are several ways in which routine testing can be expedited. Years of experience in testing lamps enable the life at rated efficiency to be computed with accuracy from tests conducted at an efficiency somewhat above normal; life testing can sometimes be shortened in this way. The integrating photometer also plays an important part in enabling measurements of total lumens to be obtained by a single measurement. This apparatus is now in regular use at the Bureau of Standards in dealing with lamps of the gasfilled type.

The most ingenious and interesting feature of the arrangements, however, is the elaborate series of slide-rule scales which form part of the photometric bench. In the ordinary way, photometric benches are now frequently calibrated direct in candle-power. But, by the aid of the slide-rule, when the watts are known, the candles per watt can be simultaneously obtained by the slide-rule equipment, and other derived quantities are similarly ascertained on their respective scales. The final touch to the equipment is given by the use of indicator cards mounted on a special carriage, on which all the data regarding a lamp can be recorded as they are determined. Truly the bulletin shows not only how photometry has become a thoroughly practical and reliable process, but that the simplification of routine work has been made a fine art in this institution.

Illuminating Engineering*

By JOHN W. T. WALSH

ILLUMINATING engineering may be defined as that branch of applied science which deals with the generation, distribution and use of visible radiation. The distribution of light is the most specialized part of the subject, dealing with such matters as the design of reflectors and fittings and the planning of installations. The last division is the most complex. It is here that illuminating engineering differs from most other branches of applied science. The eye is the final judge of the performance of any lighting system. The true illuminating engineer must, therefore, have a knowledge of physiology and psychology, at least as far as they deal with this particular one of the special senses.

It is interesting to record the pioneer work done in this country some 40 years ago by a past president of this institution. Mr. Trotter tells, in his book, how he was associated with Sir William Preece in what was probably the earliest set of illumination measurements ever made. The first paper, dealing specifically with what is now known as illuminating engineering, was read by Mr. Trotter before the Institution of Civil Engineers in 1892. Since that time the subject has advanced rapidly. It is now dealt with both nationally and internationally. The first national body of this kind to be formed in Europe was the Illuminating Engineering Society, founded in this country in 1909. The international body was formed in 1913 by enlarging the scope of the existing International Photometric Commission. In connection with this new body, the International Illumination Commission, National Committees were formed in various countries. The work was interrupted by the war, but a fresh start was made in 1921, and a second post-war session was held in 1924. The next meeting will probably be attended by delegates from at least 10 different countries.

About three years ago the desirability of standardization in some branches of illuminating engineering became apparent. Accordingly the British Engineering Standards Association was invited to undertake the work of standardization, and a sectional committee for this purpose was formed under the chairmanship of Lt.-Col. Edgcumbe. Meantime, as the result of representations from various quarters, the Department of Scientific and Industrial Research in 1923 set up an Illumination Research Committee. The remarkably wide range of interests represented in the membership of the Committee has resulted in the formulation of a well-balanced programme of research. Amongst fundamental problems now receiving attention may be mentioned the principles governing the phenomenon of glare, the effect of fenestration on the lighting of deep rooms with limited window height, and the effect of degree of illumination on ease of performing fine work. Other smaller problems of immediate importance include the effect of the position of the lamp filament on widely used types of industrial reflectors, the distribution of brightness over the surface of opal glass bowls, etc., the transmission factors of commercial window glass, and the reduction of glare in street lighting.

After this historical introduction, Mr. Walsh proceeded to explain the chief terms used in illuminating engineering, pointing out the importance of a knowledge of distribution of light from fittings, and the advantages of the modern method of rating lamps in terms of lumen-values. This summary led to a description of the chief forms of photometric apparatus, including the Lummer-Brodhun photometer. Various forms of illumination photometers, such as the "luxometer" and "Holophane Lumeter," and the instruments of Sharp-Millar, MacBeth, and Weber, were also described, and some reference was made to apparatus of a particularly simple type, as illustrated by the Benjamin Lightometer and the "foot-candle meter." Amongst sources of difficulty and error in photometry allusion was made to the problem of comparing lights of different colours, and to the uncertainties introduced by the fact that no surface complies exactly with the theoretical cosine law. At very oblique angles the departure is particularly great, a circumstance which is liable to prove troublesome in street-photometry. Hence it is usual to measure normal illumination and deduce the horizontal illumination therefrom, and instruments intended for work in streets should be furnished with a device for determining the angle at which rays are received.

In the next section of the paper the general requirements of good lighting were outlined. It is probable that the tables of values of illumination requisite for various purposes appearing in text-books should now be regarded as *minima*. But the importance of "suitability," besides adequacy of illumination, must be emphasized. It must also be remembered that the governing condition is not illumination, but *brightness*. Hence work on dark materials requires a correspondingly increased illumination. The relation between degree of illumination and efficiency of fine work has recently been studied by the Illumination Research Committee, who have found, in the case of typesetting by hand, that full efficiency was only attained with an illumination of the order of 25 foot-candles. Considerable importance is also to be attached to avoidance of glare. This effect depends on various factors, and an attempt to make allowance for these is represented in the requirement contained in the Third Report of the Home Office Departmental Committee on Lighting in Factories and Workshops. It has frequently been stated that the limiting tolerable brightness is about 3 candles per square inch, and in the Factory Lighting Committee's Report 5 candle-power per square inch is adopted. But, as Bordoni has pointed out, glare is a continuous phenomenon. It increases with the size of the source as well as its brightness, and decreases progressively as the source is removed further from the line of vision. The ideal conditions require that there should be nothing in the field of view (i.e., less than 30° above the horizontal) brighter than the object requiring attention. In street lighting there is a special difficulty in obtaining high and uniform illumination without at the same time increasing glare. In the original paper Mr. Walsh contributes an analytical study of this problem, and derives relations from which the permissible relation between height and spacing distance may be determined.

A high illumination midway between lighting units implies a correspondingly high candle-power at angles slightly below the horizontal, resulting in glare. When a source subtends less than 3° at the eye glaring effect may be regarded as due simply to the effective candle-power in the direction of view. The factors determining glare are thus: (*a*) The candle-power in the direction considered; (*b*) the distance of the source from the point considered; (*c*) the angle of elevation; and (*d*) the general brightness of the street surface. As a result of analysis it is shown that the glare effect may be represented by the relation $I_a / (h - 5)^2$, where I_a is the candle-power at the angle considered and h the mounting height. This factor may be conveniently plotted as a polar curve: the permissible value depends on the illumination, and will therefore vary according to the class of street. It is therefore possible to inscribe on the diagram limiting the values of G, the glare factor. If the polar curve falls within this graph of G it may be assumed that the installation is reasonably free from glare. The best height and spacing to avoid glare can thus be determined.

There are naturally other factors, besides illumination and glare, to be considered. For example, in order to avoid the sudden contrast to drivers of vehicles entering or leaving a main street, it has been suggested that the lighting of the side street should be gradually increased as the main street is approached.

In conclusion, Mr. Walsh emphasized the great importance of illuminating engineering to the electrical industry, pointing out that in most installations we are still far from the "saturation point," so far as illumination provided is concerned.

* Abstract of paper read before the Institution of Electrical Engineers.

The Problems of Public Lighting by Electricity*

By Lieut.-Commander HAYDN T. HARRISON, R.N.V.R.

IN his introductory remarks Lieut-Commander Harrison recalls the paper on "Standard Clauses for Inclusion in a Specification of Street Lighting," read before the Illuminating Engineering Society in 1913, and points out that there has been little advancement in public lighting since that date. The explanation is generally to be found in the fear of increased costs and additions to the lighting rate. Hence the author seeks to show how the requisite improvement in illumination can be secured without rates being materially increased.

Public lighting may be divided into two classes, the first relating to the lighting of high-class thoroughfares, shopping districts, etc.; the second, which covers about 90 per cent. of all public lighting, referring to the less important thoroughfares, side streets, residential districts, etc. The divergence between the two classes may be as much as 200 to 1 as regards minimum illumination, but as the safety of the public is not exclusively controlled by that factor the difference is not so great as might appear.

The author next reviewed various examples of street lighting. The main streets in the City of London form one of the best examples, particularly Cheapside, which receives a minimum horizontal illumination of 1 foot-candle at a consumption of approximately 5 watts per linear foot. Oxford Street, with a minimum of 0.2 foot-candle, but commendable absence of glare, is also mentioned. Other good instances are to be found in Manchester, and other provincial cities. From such cases it is concluded (*a*) that the best results are obtained from lamps centrally situated, (*b*) that modern traffic conditions, combined with narrow streets, render it advisable to reduce obstructions by dispensing with standards as far as possible, and (*c*) that further increase in the brilliancy of light sources is inadvisable, unless the height is materially increased.

It is a mistake to try to obtain higher illumination by merely increasing the power of existing light sources, as this leads to accentuation of glare. The solution of the problem lies in the use of electric gasfilled lamps which combine the advantages of high efficiency, small weight and low cost of maintenance. To take full advantage of these factors the problem must be attacked *ab initio*, and the common practice of using existing supports abandoned. Closer spacing will lead to economy and reduce the power of light sources required. Placing lights on both sides of the road increases spacing, results in some of the buildings being more highly illuminated than the road, and means a waste of luminous energy. To illustrate this the author, in the original paper, includes a diagram and table which clearly indicates the benefits of central suspension. Thus, according to the arrangements, the kilowatt per mile needed to furnish 1 foot-candle may vary from 40 to 132. In streets where there are buildings on either side these form a natural fixing for suspensions. In other cases steel columns set back from the road against the frontage would be inconspicuous and free from obstruction. In shopping districts, where the advantages of better illumination are fully realized, no objection by those occupying houses is to be expected; in any case, the addition of a small support is to be preferred to a street standard extending upwards in front of a building. By removing such obstructions street safety is improved. There should, therefore, be no difficulty, with the help of the Electricity Commissioners, in obtaining Parliamentary powers to secure permission.

The overhead suspensions should also form the necessary distributing conductors. Experience with tramway routes has enabled all difficulties to be overcome, and the public have become familiarized with the sight of overhead wires. The advantages to be gained include: (1) Increased and more even illumination on the road and pavement, and more efficient distribution of light; (2) increased visibility obtained by raising the light sources and reducing their brilliancy; (3) road obstructions are dispensed with and the footways left clear for pedestrian traffic; (4) lower initial cost, due to the elimination of ornate columns and brackets and the reduced number of underground service points, etc.; (5) lower running costs, due to reduced consumption of electricity and the automatic group control of lighting and extinguishing; (6) greater reliability owing to decreased number of underground points and accessibility of conductors. The only objections that might be raised are those based on æsthetic considerations, but owing to the small dimensions of the supporting wires, these should be barely visible at the height at which they are placed.

In the next section of the paper the author discussed the details of such suspensions, pointing out that the attention required is small. Modern gasfilled lamps only require renewal two or four times per annum, and cleaning is generally carried out 12 times a year. Access to the light sources would be gained by electrically propelled tower wagons. In practice, an average life of 2,000 hours can be obtained by operating lamps at a pressure of 5 per cent. below the normal. This would, however, result in about 20 per cent. diminution in candle-power, and the expediency of this device depends upon the relative costs of lamps and electricity.

The prime cost of an installation on the lines described would work out as follows:—

	Per mile
(*a*) Minimum 1 foot-candle	£650
(*b*) Minimum 0.5 foot-candle	£575
(*c*) Minimum 0.25 foot-candle	£525

Maintenance and operating costs, including electrical energy at 1d. per unit, four lamp renewals per annum, lighting and extinguishing, cleaning, interest and sinking fund on a 10 years' loan basis are approximately:—

	Per mile per annum
(*a*) Minimum 1 foot-candle	£1,000
(*b*) Minimum 0.5 foot-candle ...	£600
(*c*) Minimum 0.25 foot-candle ...	£475

Comparison with existing practice shows that for the same standard of illumination the operating cost above would be little more than that required to cover the interest and sinking fund, despite the fact that these do not include the mains.

In dealing with less important thoroughfares the author suggests similar methods, but with a lower illumination and on more inexpensive lines. The minimum should, however, not be less than 0.1 foot-candle, which could be obtained from 100-watt lamps spaced 100 feet apart and 25 to 30 feet high. The capital cost would not exceed £450 per mile, including conductors. The operating charges, assuming electricity at 1d. a unit, would probably be about £165 per mile, which is much the same as that of the present form of "beacon lighting," giving a minimum of 0.0015 foot-candles—i.e., practically darkness. Side streets and alleys, being narrow, could readily be dealt with by means of central suspension. Streets in middle-class residential districts are more difficult, owing to the buildings being set back from the road, which may be lined with trees. But, in any case, the attempted conversion of existing posts rarely yields good results. If existing posts and lanterns must be utilized, the numbers should be at least doubled in most types of streets in order to reduce the spacing to a reasonable limit; the cost of such a change would, however, probably exceed that of a complete new installation on modern lines.

The treatment of arterial roads and highroads carrying high-speed traffic through rural districts is next dis-

* Abstract of paper read before the Institution of Electrical Engineers.

cussed. Experiments have been made with sources of illumination rigidly fixed below eye-level in order to prevent glare completely by removing the lamps (which are screened) from the field of vision. Such methods would meet all the requirements of authorities who have issued regulations on the subject of headlights, but it is doubtful whether the method will ever become popular with the public. After discussing the conditions in some detail the author concludes that the solution of the problem is to use fixings, say 30 ft. high, on which light projectors can be rigidly supported. Units should be spaced 17 or 20 to the mile. To produce an illumination of 0.25 foot-candles on a vertical surface on any part of the road, the maximum candle-power should rise to about 40,000 at a distance of 300 to 400 feet, and would be diminished at 250 feet to 16,000, and at 150 feet to 6,000 candle-power. At 100 feet it would fall to zero as the light from the adjacent unit comes into operation. Thus the light from adjacent units is not utilized, a condition which is favourable to elimination of glare. This result can be gained by using 50-watt lamps of low voltage (10 to 12 volts), of which there would be two at each support, giving a total of about 2,000 watts per mile. The capital cost would not exceed £300 per mile, and the cost of electrical energy (at 1d. a unit) would be about £35 a mile. The cost of lamp maintenance should not exceed £2 per point, or £40 per mile per annum. The scheme has the merit that a high degree of vertical illumination suitable for traffic requirements is provided, and all roads could be efficiently illuminated for a relatively small capital expenditure. A similar system (the "Novaluxe") has been adopted in America, though in this case high-voltage lamps are used, so that less effective concentration is possible.

In conclusion, some reference is made to the lighting of parks and large open spaces. Such cases cannot be dealt with on the lines suggested in this paper, but it is suggested that large open spaces are best illuminated by powerful sources on very high standards, designed to produce approximately even illumination.

National Illumination Committee of Great Britain

Chairman's Report for the year 1926, presented at the Special Annual Meeting of the Committee on Tuesday, the 1st February, 1927

A CHANGE has been occasioned in the personnel of the Committee during the past year through the retirement of Mr. F. W. Goodenough, who has ably represented the Institution of Gas Engineers on the Committee for many years. His place has been taken by Mr. H. E. Copp, manager of the Hull Gas Works.

It will be remembered that in 1924 the Committee felt that the time had arrived when an increase in standardization work could profitably be undertaken, and that, largely in consequence of representations by this Committee, the British Engineering Standards Association formed a Sectional Committee on Illumination, of which members of this Committee form the nucleus. The work of the British Engineering Standards Association Committee is progressing very satisfactorily, and five specifications dealing with important illumination materials or problems have been issued or are on the point of completion. These specifications are quoted below:—

(1) British Standard Specification for Portable Photometers. B.S.S. No. 230—1925.

(2) British Standard Glossary of Terms used in Illuminations and Photometry. B.S.S. No. 233—1925.

(3) British Standard Specification for Industrial Reflectors for Direct General Lighting, No. 1 Dispersive (Vitreous Enamel) Type. B.S.S. No. 232—1925.

(4) British Standard Specification for an Illumination Fitting of Translucent Glassware for Interior Lighting.

(5) British Standard Specification for Street Lighting.

The work of the Sectional Committee in more detail is summarized in the attached report by Mr. Good, of the British Engineering Standards Association.

It has been brought to the notice of the Committee that there is a proposal to standardize miners' lamp bulbs. This is a matter which the National Committee considers to be very important and worthy of support. In consequence, the British Engineering Standards Association were informed that this Committee was very much in favour of such standardization, and would be glad to co-operate and render any assistance possible. It is understood that the proposal has been considered favourably, and that it will be dealt with in the near future.

With regard to the proposed formation by the British Engineering Standards Association of a Committee on the subject of Glare from Motor Car Headlights, the Chairman has discussed the matter with various interested organizations. It appears that the consensus of motorist opinion in this country is that it would still be premature to attempt anything in the nature of standardization, or even of definite recommendations as to lines on which development should take place.

It has not proved possible to hold the proposed plenary session of the International Commission on Illumination in New York in 1927, so that it has been postponed provisionally to 1928. In the meantime, however, meetings of the executive and technical committees extending over several days are being arranged in Rome for September, 1927.

It is of interest to record that Belgium, Germany and Japan have recently become members of the International Commission, which now includes Belgium, France, Germany, Great Britain, Italy, Japan, Switzerland, and the United States of America.

K. EDGCUMBE.

February 1st, 1927.

British Engineering Standards Association

Draft Report on Work of Illumination Section during the past year, for the British National Committee of the International Illumination Commission

THE progress of the work of the Illumination Section of the British Engineering Standards Association during the past year is as follows:—

The Sub-Committee on Illumination Glassware (39/3/-) has practically completed its first Specification for an Illumination Fitting of Translucent Glassware for Interior Lighting. A panel has been appointed to consider the question of neck dimensions of the glassware and galleries, and it is hoped that this panel will be able to arrive at its conclusions within the next few weeks.

It was reported last year that difficulty had been experienced in obtaining the co-operation of the glass-makers; this difficulty has been overcome during the past year, and the Committee has had the benefit of the assistance of five or six of the leading glass-makers during the past six months.

The Committee is also trying to take into account the requirements of those using gas as the illuminant, and the gas interests are assisting on the panel dealing with neck dimensions and galleries, and it is hoped that the Specification, when completed, will be suitable for adoption by both the gas and the electrical industries.

The Sub-Committee on Industrial Reflector Fittings (39/4/-), as was reported last year, completed the Specification No. 232, "Industrial Reflector Fittings for Direct General Lighting, No. 1 (Dispersive Type)." Since the issue of this specification two points in regard to it have been brought to the notice of the Association, and the Committee have agreed to alter the Table to show the gauges of metal instead of the thicknesses of steel, a note being added giving the trade tolerances usually allowed on these sheets. The note to Clause 6 has also been altered to read:—

> "This figure is *based upon* and complies with the Recommendation of 20° from the horizontal for light sources at distances of not less than six feet, contained in the Second Report of the Departmental Committee on Lighting in Factories and Workshops, 1921,"

the words "based upon" having been added, and the words "but may be altered later" deleted as being liable to cause confusion, owing to their being interpreted in some instances to mean that it was not necessary to comply with the Home Office recommendations.

In the work of both this Committee and the Committee on Illumination Glassware, difficulty has been experienced owing to the wide tolerances allowed on the light-centre length of electric lamps (see B.S.S. No. 161), and this sub-committee are consulting with the Electric Lamp Sub-Committee in regard to the matter. It is hoped that, even if a common standard cannot be set up for all types of lamp, light-centre lengths within narrow limits can be established separately for (*a*) pear-shaped bulbs, and (*b*) spherical bulbs. The reflector fitting could then be marked to indicate the type of lamp to be used with it.

This subject is recognized as being of considerable importance in the case of the dispersive type of reflector, but is of even more importance in the case of the other types of reflector which the Committee has in mind, and the preparation of further specifications has been deferred pending some agreement in regard to the light-centre lengths.

The Sub-Committee on Street Lighting (39/5/-) has completed its draft specification. Reference was made last year to the question of glare, and it has been found possible, thanks to Mr. Walsh, of the National Physical Laboratory, and to the very considerable amount of work done by the G.E.C. Research Laboratories in investigating Mr. Walsh's proposal, to include a reference to glare in the specification, and a method has been devised, and is given as an Appendix, whereby the degree to which a given installation may be expected to be free from glare may be calculated approximately.

This draft specification is being presented for discussion at the Institution of Electrical Engineers on March 3rd, the Illuminating Engineering Society on March 8th, and the Council of the Institution of Gas Engineers quite shortly.

February 1st, 1927.

The Effect of Eyestrain on the Output of Linkers in the Hosiery Industry*

A very instructive report on the above subject, by Messrs. H. C. Weston and S. Adams, is issued by the Industrial Fatigue Research Board. In the preface it is pointed out that many industrial processes involve the clear perception of fine detail, and some evidence is available that continuous work of this nature tends to have a deleterious effect upon eyesight. Thus a special examination of 480 myopic subjects showed that of those who had not been engaged on fine processes 9.4 per cent. had failed at some time owing to visual troubles, and of these 7 per cent. sustained definite damage to the eyes. But in the case of those engaged in occupations involving habitual close eye-work such as sewing, the corresponding numbers rose to 53 per cent. and 15 per cent.

The perception of fine detail depends on two factors, the size of the retinal image and the illumination of the object viewed. The first requirement is obviously good lighting, and it has been shown that output in such processes can be notably increased by increasing the illumination.

But in certain extreme cases the details are so exceptionally fine that illumination, however high, does not wholly eliminate the necessity for near vision, with its disadvantages of excessive accommodation and convergence. An instance is afforded by the process of "linking" in hosiery which is dealt with in this report. The process is described in detail. Linking completes the work of the circular knitting machine, by connecting two rows of stitches or loops in a gap across the toe portion of the hose. The machine consists of a dial rotating at 16 to 18 revolutions per hour, and the machines have 20 or 22 needles to the inch. The operator sits on a low stool with the eyes usually five to eight inches from the needle-points. The work is very fine. Many linkers find it necessary to wear glasses after several years of this work, and probably many others do not resort to them who would be well advised to do so.

The report contains records of output showing that for each subject a considerable increase in the rate of working, accompanied by a reduction of fatigue, has been effected by the use of suitable glasses. There appears no reason why beneficial results should not follow the use of suitable glasses even by persons having normal vision, but the glasses must naturally be selected under proper advice according to the needs of the individual.

The importance of these researches lies in the fact that, if the eye is incapable of seeing focussing detail clearly, no amount of illumination will make good the deficiency. Failure to realize this fact is not infrequently the cause of unjustified complaints of inadequate lighting.

*Report No. 40. Issued by the Industrial Fatigue Research Board: available from H.M. Stationery Office, Kingsway, London: 1s. net.

POPULAR & TRADE SECTION

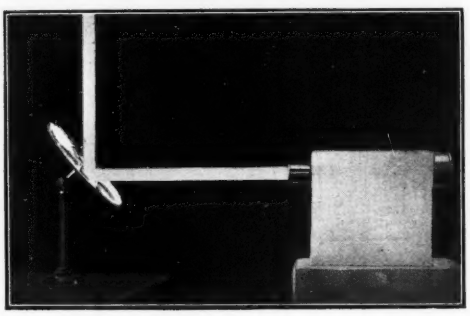
COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

Principles of Light Reflection and Diffusion

IT has already been pointed out that light may have opposite effects; when correctly used, it makes vision possible, but when "glare" is present it defeats this object. Example: If you are in a motor-car, behind powerful headlights, every detail of the road is rendered visible, but if you are walking towards the car you are blinded and unable to distinguish anything.



Apparatus for illustrating Reflection from Difference Surfaces.

The "raw" light from the electric lamp is usually very bright and its distribution invariably requires modification. Hence, it is necessary to control the "raw" light from a lamp, directing it in order that illumination may be obtained at the working plane, and so arranged that it is free from glare.

Control of Light.

Reflection.—When white light falls upon a coloured object, as for instance, red, all the waves of light, excepting those corresponding to red light, are absorbed, and only the red light is reflected. This is the reason why the object appears red. Light of that particular wavelength stimulates the eye, and produces a definite sensation. An object appears to be black when it absorbs all the light which falls upon it.

Mirrors.—When light falls upon a mirror it is regularly reflected, as shown in Fig. 1, glancing off at a definite angle. Use of this is made in the design of mirrors for searchlights, some forms of shop-window reflectors, and motor-car headlights. By this means it is possible to so arrange that all the light from a lamp is projected in a definite direction. When plain mirrors are used for reflection there are often objectionable variations in the beam produced. This can be, in a large measure, eliminated by making the surface of the mirror slightly irregular, as in the case of hammered glass.

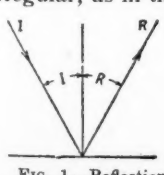


Fig. 1.—Reflection from Polished and Mirrored Surfaces.

Fig. 2.—Perfectly Diffused Reflection.

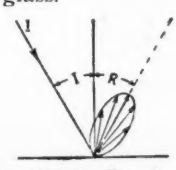


Fig. 3.—Spread Reflection

Diffuse Reflection.—When a beam of light falls upon a matt surface, such as blotting-paper, plaster, flat paints and white ceilings, the reflected light is sent in all directions, see Fig. 2. It will be seen that there is not a definite beam, since the light is scattered. Many surfaces are a combination of these two extremes, and partially reflect and partially scatter the light. This two-fold effect is produced by vitreous enamelled reflectors, see Fig. 3.

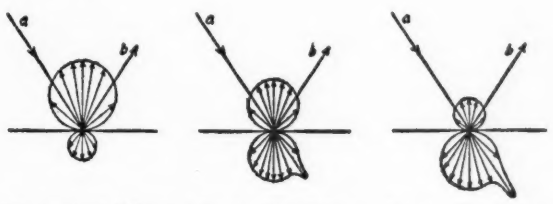


Fig. 4.—Good Diffuser. Fig. 5.—Fair Diffuser. Fig. 6.—Poor Diffuser.

Reflection and Transmission Characteristics of Glass, showing diffuse Reflection as from a piece of Opal Glass, the surface of which had been frosted.

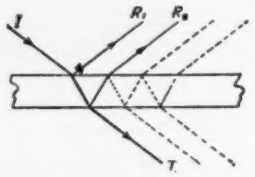
Total Reflection.—When a beam of light strikes a piece of plate glass at certain angles the glass behaves as a mirror, and reflects the light in a definite direction. A number of glass reflectors employ this principle, the reflection actually taking place from the surfaces of prisms, and controlled as per the illustration. A good mirror, glass prisms, and the best of white surfaces, reflect approximately 90 per cent. of the incident light, but it will be seen from the above that the manner in which the light is redirected is vastly different.

Reflecting Powers of Different Surfaces.

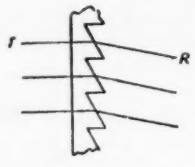
Aluminium Paint	72
Black Paint, Matt	6
Brick, Dark	22
Brick, Light	46
Buff, Light Matt	36
Caen, Stone	72
Concrete, Unpainted	45
Cream, Matt	62
Galvanized Iron, Unpainted	16
Glass, Ordinary	14
Grey, French Matt	28
Grey, Dark Matt	22
Green, Light Matt	41
Green, Dark Matt	27
Ivory, Glossy	69
Ivory, Matt	64
Plaster (Keene's Cement Finish)	75
Plaster Board	60
Red Carmine, Matt	9
Steel, Unpainted, Structural	16
Tile, White, Glossy	80
White Blotting Paper	82
White Paint, Glossy	78
White Paint, Matt	77

Transmission of Light.—Light is controlled by substances which are either transparent, translucent or opaque. Those which only reflect light falling upon them are said to be opaque. Transparent substances permit the light to pass through them unimpeded, and a beam of light would emerge in a definite direction, whereas, in the case of translucent materials, the light in process of transmission is broken up and emerges diffused, radiating in all directions.

Diffusion.—When light passes through translucent material it is broken up and emerges in all directions, as shown in Fig. 4. With a thoroughly diffusing medium, the source of light cannot be seen. This principle of light control is used in all kinds of totally enclosed fittings employing opal or opaline glass, which are so much used at the present time.



Reflection and Refraction by Plane Polished Glass.



Refraction Prismatic Glass.

Total Reflection of Glass Prisms.

Reflection of a Lens.

Refraction of a Prism.

Refraction.—When light passes through a piece of plate glass it emerges at the same angle as that at which it enters, but if the piece of glass be thicker in one part than in another, then the ray of light will be bent towards the thick part. This method of controlling light is that which is used in lenses of optical lanterns, lighthouse lenses, and in street-lighting refractors. In the case of the refractors a number of prisms are used, the light being bent towards the thick part of the prism. This method of control is also used in some forms of glass fittings.

General.—It often happens that some or all these methods of light control are in use at once. For instance, in the case of the semi-indirect or opal bowl, some of the light is diffusely transmitted through the glass, while some of the light is regularly reflected, and yet another part is diffusely reflected.

As will now be seen, every fitting has some definite method of light control, and can be accurately designed in order to give a specific result, the polar curve of distribution being modified in accordance with the requirements. Some fittings are designed to have flat bat's-wing polar curves, as, for instance, refractors used for street lighting, and some have polar curves suitable for effectively lighting interiors.

Classification of Lighting Installations.

Light is controlled by a variety of means, and produces one of four methods of lighting:—

1. *Direct Lighting.*—Part of the light from the lamp passes directly to the plane of work and part reaches it by reflection from the reflector. Very efficient—inclined to give glare—hard shadows.
2. *Indirect Lighting.*—The whole of the light from the light source is directed towards the ceiling, and only by reflection illuminates the working plane. Good diffused light—restful—expensive to maintain—absence of shadows.
3. *Semi-Indirect Lighting.*—Some of the light passes through a diffusing bowl direct to the working plane, and the remainder is sent upwards towards the ceiling and is there redirected. Good appearance—expensive to maintain.
4. *Totally Enclosed Diffusing Units.*—The light source is totally enclosed with diffusing glassware; some of the light reaches the working plane directly through the glassware, and some of it passes through the glassware to the ceiling and is there redirected. Free from glare—easy and cheap maintenance—good appearance.

Sheffield Illumination Society

The members of the Sheffield Illumination Society spent a very enjoyable evening in the Council Room of the Montgomery Hall, Sheffield, on the 1st March, when Mr. H. Girdlestone, of the Electric Lighting Service Bureau, delivered a paper on "Light in Advertising."

Mr. Girdlestone dealt with the various kinds of illuminating electric signs, illuminated poster hoardings, floodlighting, etc., and some very interesting information was supplied.

The lecturer stated that the earliest recorded electric signs were the "Edison" signs made by W. J. Hammer in 1882 and 1883, the first being installed in the Crystal Palace, and a smaller one, with a flasher, installed in Berlin.

The chief factors in the development of electric signs, i.e., the construction, various types of lamps available for particular signs, switchgear (which introduces movement to the sign, thereby increasing its attractiveness), and other characteristics, were very carefully considered.

Continuing, Mr. Girdlestone discussed the lighting of poster hoardings, and remarked that in the daylight hours the posters tell their story to passers-by, but after dusk they are almost inoperative, this practically meaning that the whole publicity value of the advertisement is lost during the evening hours, and this is the time of the day during which the poster could make a great appeal; and, when the minds of the public are in a very receptive frame, business being over for the day, they are much more likely to examine anything which may present itself. In this country over 90 per cent. of the posters cannot be seen at this most important period of the day. It was pointed out that in America the practice of electrically lighting hoardings is almost universal, and that they are even going one step further, for, in many instances, the artist selects his colours and designs his picture so that it will appear at its best when illuminated electrically.

The question of floodlighting was next under discussion. Mr. Girdlestone stated that floodlighting in this country is still in its infancy, but that its future is distinctly hopeful, since many new buildings are finished in white stone or concrete, and architects are usually favourably inclined to floodlighting, as it enables their scheme to be seen for a larger number of hours per day, and also it accentuates special features.

A good number of lantern slides illustrated the lecture.

In the absence of the President (Mr. H. Lazenby) through illness, Mr. J. F. Colquhoun (Public Lighting Engineer) occupied the chair, and thanked Mr. Girdlestone for the very pleasant and educative evening he had afforded to the members.

The Illuminated House-Number

We recently mentioned the regulations being introduced in Helsingfors (Finland) making the illumination of names or numbers of houses at night compulsory. *The Sudd. Elektre-Anzeiger* has also been pointing out the need for this practice in Germany, and includes an illustration of a house equipped with an illuminated panel. Undoubtedly the best method is to instal a panel of diffusing glass, with the number painted on it in bold letters, illuminated from *inside* the house. In many cases this indication could be readily provided immediately above the front door, so as to receive light from the source illuminating the hall. If this is not practicable, a recess for the plate, and a special lamp of small wattage to illuminate it, may be installed. We imagine that in the houses of the future arrangements for lighting the name of the house or number will form a standard feature of the wiring. On general grounds it is to be preferred that the illumination should be effected from inside. The installation of outside lamps to illuminate a design is less bold and effective; also the wiring outside the house walls is more liable to give trouble, owing to damp, unless carefully executed.

The British Thomson-Houston Co., Ltd., Crown House, Aldwych, London, W.C.2

Some Notes on the British Industries Fair, 1927

(Held at the White City, London, February 21st - March 4th)

By A Correspondent

IMPRESSIONS derived from a brief visit suggest that lighting appliances did not figure very largely at the British Industries Fair, although, as will be seen, there are a few specialities that deserve mention. So far as the general lighting of the exhibition is concerned, the methods are in the main satisfactory, semi-indirect lighting being widely used, though in some sections of the exhibition ordinary conical opal shades and clear bulb lamps give a less pleasing effect. On some stalls, however, such units have been mounted above the upper linen canopy with resultant freedom from glare, though the illumination might have been increased with advantage. Many of the exhibits lend themselves well to special illumination. In the cases staged to illustrate the possibilities of Kenya, the Sudan, whaling at the Falkland Islands, etc., concealed lighting is effectively employed, and the panoramic scenes make a pleasing variation to the stands of firms. The writer noticed in the Indian and other exhibits the use of tables with tops of diffusing glass under which coloured lights are mounted; the effect of the upward coloured light on the appearance of articles displayed is pleasing, and gives variety to the general impression. Amongst special efforts by exhibitors one may mention several instances in which concealed lights are used to illuminate the contents of cases containing porcelain, crystalware or silverware, and there is no doubt that the care spent on such special methods has been well worth while.

Exhibits dealing with lighting may be broadly divided into two classes, those dealing with illuminated signs, etc., and examples of fancy shades. Near the entrance of the exhibition the display of Mur-Ray Signs Ltd. attracts attention. The display consists of a considerable variety of "night and day" signs outlined in lenses of glass of various colours. When light from a small headlight is directed on to the array of signs the effect is very striking, the lenses appearing as bright points of light. For traffic signs the device seems to have special applications, the "dog's eye" lenses serving alike to indicate garages, for directions, and as rear-lights for cycles. The importance of design was well illustrated by a simple experiment. The familiar red triangle outlined with the Mur-Ray lenses showed up brightly in the headlight's beam, but a similar triangle outlined in glass beads of imperfect contour and unscientific design quite failed to collect the light and was almost unrecognizable.

Luminous signs in considerable variety were exhibited by the Attracta Electrical Co. Besides the familiar neon and other types the stall contained good examples of the "Nigrasine" animated sign, in which letters or objects are depicted by means of a pattern of moving drops of coloured liquid kept in motion within tubes by a small motor. The motion of these drops naturally catches the eye, and the device is capable of many different applications. Another ingenious form of sign only recently introduced depends on the use of a series of enamelled metal "shutters" which are illuminated by light emitted through interstices between the individual inclined strips. Thus the whole surface of the sign is illuminated but the source is completely concealed from the eye. This sign can be readily adapted to take changeable-letter devices.

No less than 14 firms exhibited lamp and candle shades, and it is evident that the design of fancy shades of this kind is becoming quite an industry. Many different materials are now represented, coloured silk being perhaps still the most popular, though good examples of parchment and celluloid, etc., bearing stencilled or hand-painted signs were also in evidence. The lightness, simplicity and adaptability to pictorial effects of such shades are naturally recommendations. Some of the most effective utilised a comparatively opaque material, light being allowed to penetrate through certain elements in the design—for instance, to illuminate the torches carried by figures painted on the main fabric.

The Science of Illumination

For some time past a Committee of the Department of Scientific and Industrial Research has been directing a number of experimental investigations into the technique and theory of illumination. The reports upon these researches will provide all illuminating engineers with an up-to-date technical library at a very small cost.

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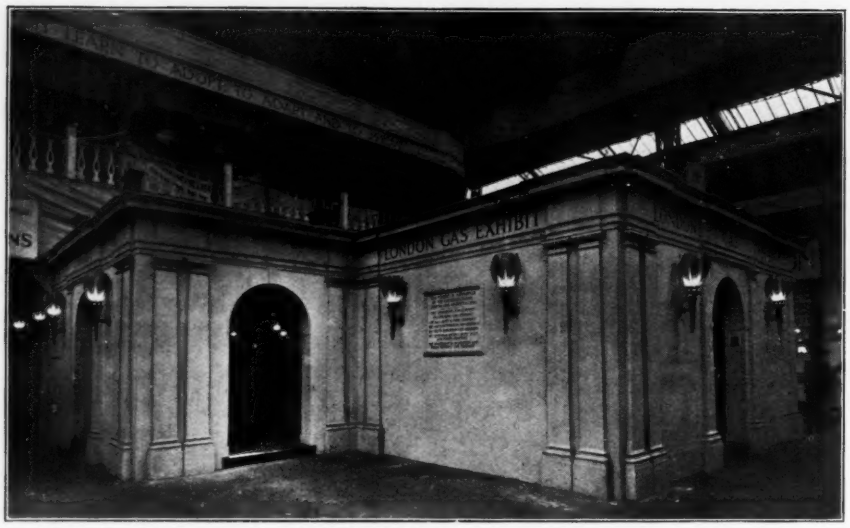

FIG.1.—The dignified exterior of the Joint Exhibit of the London Gas Undertakings at the Ideal Home Exhibition was lighted by 14 " Flambeaux " brackets in bronze finish, with 3-light super-heated gas burners, Vitreosil mantle protectors, and flame-coloured silk shades.

Exhibitions and Gas

TWO large and important exhibitions have been held during the past few weeks—the British Industries Fair (with its sections at the White City, London, and at Castle Bromwich, Birmingham), and *The Daily Mail* " Ideal Home " Exhibition at Olympia.

These exhibitions were of interest to illuminating engineers and to all whose desire it is to reduce the smoke nuisance by extending the use of the smokeless and labour-saving product of the gas industry for lighting, heating, cooking, water-heating and industrial purposes.

GAS AT CASTLE BROMWICH.

The Birmingham Section of the British Industries Fair was notable for very fine examples of gas lighting. Buildings " A," " B " and " C " were lighted by 1,000 candle-power gas lamps. The gas was compressed in view of the public, the compressing plant forming a display which attracted much attention. The main gangway, the kitchens, dining-rooms, smoking-rooms, bars, and the new fire station were all lighted by low-pressure gas lamps and burners, as also were the roadways round the exhibition. The new main entrance to the building was made conspicuously bright by a 4,500 candle-power high-pressure gas lamp.

The catering arrangements were carefully attended to, and the extent of the demand for food may be judged from the fact that fifty odd gas cookers, as well as gas hot-plates, grilling stoves, water-heaters and the like, were required to cope with it. Hot water for lavatory basins was also heated in gas boilers.

With these requirements of the exhibition authorities and the demands from numerous exhibitors showing industrial gas-fired appliances, and lighting, heating, cooking and water-heating apparatus, it is not surprising to learn that every hour throughout the period of the exhibition some 20,000 cubic feet of gas were consumed.

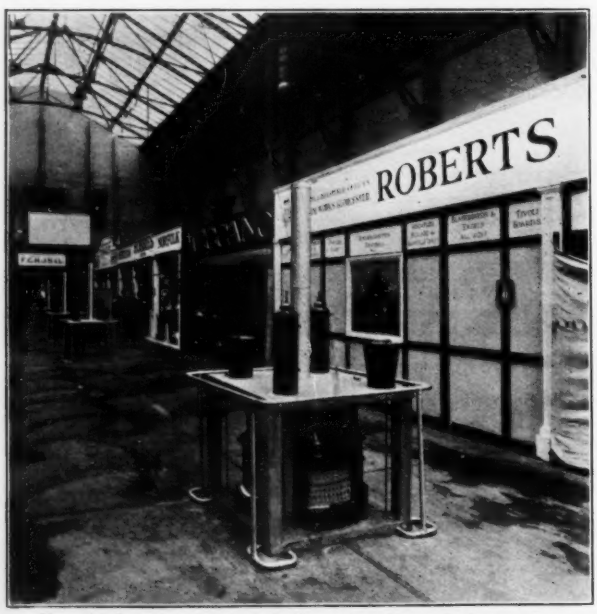

FIG. 2.—Some of over 350 Radiant Gas Fires which, together with 56 Gas Radiators, heated the various sections of the British Industries Fair at the White City.

GAS AT THE WHITE CITY.

The London Section of the Fair gave equally good opportunities to stall-holders and visitors to appreciate the advantages of this smokeless fuel.

The heating of the buildings was carried out mainly by gas. No less than 355 modern radiant gas fires and 56 gas radiators were utilized for this purpose. The radiators were fixed on the bridges and corridors leading from one section of the exhibition to another. The gas fires were fixed in two's and four's in special cubicles placed at convenient points in the various halls. They were fitted with guards to prevent all possibility of the clothes of passers-by coming into contact with the glowing radiants.

One of the chief advantages of this system of heating for exhibitions (and, for that matter, for other large business premises) is the ease with which the heat can be controlled to meet local requirements. This was an important point at the White City, in view of the different classes of articles shown there. For example, in the " Piano " section it was necessary to maintain a steady heat night and day during the run of the exhibition. On the other hand, such conditions would not have been equally prized by the " Refrigerator " section. As gas was used for heating these buildings, the Department of Overseas Trade had only to give definite instructions as to the numbers of gas fires to be lighted up in each section, and the times at which they should be extinguished each day, in order to comply with the particular requirements of the stall-holders.

That the Department of Overseas Trade is particularly satisfied with the heating system adopted will be appreciated when it is known that while only 265 gas fires were used to heat certain sections of the buildings in 1926, the number required this year to heat a larger area was

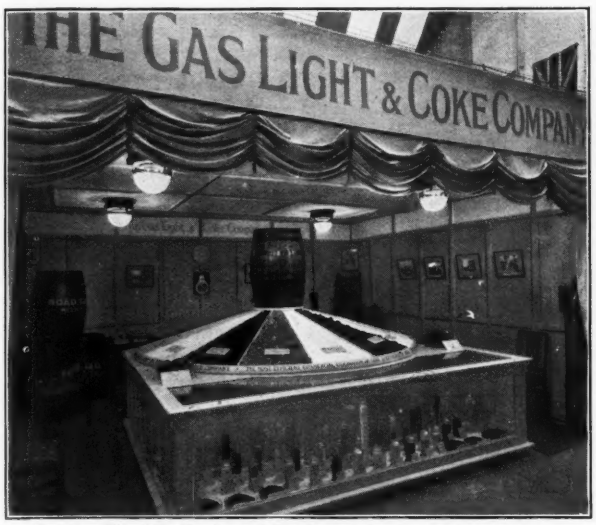

FIG. 3.—The "By-Products" Exhibit of the Gas Light and Coke Company at the British Industries Fair. The revolving table was well illuminated by ceiling ventilating gas lights and concealed "directive" gas lamps.

increased to over 350. There is every reason to anticipate an even more extensive use of gas for this purpose in subsequent fairs.

The catering at the exhibition was carried out by Messrs. Ye Mecca Ltd., in whose restaurants and bars gas was used for all cooking and water-heating operations. The "safety" alternative lighting throughout the exhibition consisted of 7-light gas lamps.

Two individual exhibits at the fair were of particular interest to illuminating engineers. The first was a stand showing the by-products of gas manufacture. In the centre was a large revolving table divided into sections, each section containing one of the many valuable by-products of gas manufacture. On the outside edge of the table the following inscription was painted:—

> "The most efficient commercial utilization of coal is effected by high-temperature carbonization, yielding gas, coke, ammonia, tar and other products. From these last named modern chemical industry produces road tar, fuel oil, motor spirit, dyes, explosives, drugs, perfumes, etc."

This revolving table and the wording attracted the attention of nearly everyone who entered the exhibition, and did so partly on account of its novelty, but also on account of the excellent manner in which it was lighted. The lighting consisted of four ventilating gas lamps arranged in the panelled ceiling, and a series of "directive" gas lamps concealed behind the facia of the stand and focussing light on to the revolving table.

The second exhibit of interest was a series of illuminated pylons arranged by the Gas Light and Coke Co. These pylons were provided with four very beautiful gas fires, one on each side, and above these fires were four illuminated coloured panels measuring 3 ft. 10½ in. by 2 ft. 2 in. The distribution of light over the surfaces of the panels was achieved by the use of special reflectors. The light for each panel was provided by three 2-light super-heated gas burners placed inside the pylons. The views shown in the panels consisted of vistas through the various new showrooms of the Gas Light and Coke Company.

The simple dignity of these pylons and the particularly even illumination achieved on the panels by the gas light open up new possibilities for the use of gas in the showrooms and windows of high-class shops.

A Daily Quarter-Million Gas Consumption.

The demand for gas at the British Industries Fair at the White City amounted to no less than 250,000 cubic feet per day

Gas at the Ideal Home Exhibition.

At Olympia gas was again very much to the forefront. The co-operative display of the London gas undertakings consisted mainly of a series of showrooms and model rooms designed by one of our leading architects, and fitted up on the most modern lines with gas appliances. The fires shown were of distinctive and dignified design. The lighting fittings were controlled by distance switches. One section was specially prepared for the benefit of architects and builders. In it was shown a series of inexpensive gas fires and surrounds, with flues built in the thickness of the walls. These fires were of the type which is being fixed in many public and private housing schemes. To show the construction of the flues and the simple methods of fixing the fires and surrounds, each gas fire and surround was fixed on a hinge, which allowed the flues and backs of the fires to be examined at will. This section was specially visited by many of the leading architects and builders of the day, who expressed their appreciation of the practical nature of the exhibit. It showed in particular the ease with which these types of fire and surrounds can be installed, the important economies in building costs which can be effected, and

FIG. 4.—One of several Pylons at the British Industries Fair, showing modern Gas Fires and, above them, semi-transparent coloured Panels, each illuminated from behind by three special 2-light super-heated gas burners.

FIG. 5.—This year the Overseas Buyers' Club was heated by a gas fire. Visitors had the greatest difficulty in realizing that it was only a temporary setting. The deep recess of black tiles brought out the beauty of design of the high-class grate.

FIG. 6.—The Gas Cooker Section of the London Gas Exhibit at the "Ideal Home" Exhibition. Each cooker was partitioned off to enable visitors more easily to examine one range at a time.

FIG. 7.—One of the sections of the Gas Exhibit at Olympia, showing high-class Gas Fires in modern surrounds, and switch-controlled gas-lighting fittings.

the real advance towards smoke abatement which will result from their increasing use in housing schemes.

EMPIRE MARKETING BOARD.

The Empire Marketing Board had some particularly fine exhibits in the New Hall Gallery. Opposite them were four fully-equipped kitchens, where hourly demonstrations of the best methods of cooking Empire produce were given. The assistance of the British Commercial Gas Association was given in the fitting up of the kitchens. For the cooking operations they installed in each kitchen one of the latest types of raised gas cookers. In the two large kitchens there were also gas-operated refrigerators, which gave seven hours' refrigeration at the remarkably low cost for gas of one penny. Behind the scenes Ewart's and Parkinson's geysers provided the "ever-ready" supply of hot water required for washing-up purposes.

The demonstrations in these kitchens drew crowds of women, who were afterwards invited to examine the cookers and other gas appliances and sample the dainty dishes prepared in them. These demonstrations will undoubtedly have done much to encourage women to purchase the high-class food products of our colonies; at the same time they have brought out in an unmistakable manner the high standard of perfection reached by the modern gas range, which, even in its most advanced form, is marketed at a comparatively low price.

One of the two demonstration kitchens of the Good Housekeeping Institute was also equipped with gas apparatus which has received the approval of the Institute.

A PRIZE-WINNING ALL-GAS HOUSE.

In the "Village of New Ideas" the prize-winning house in Class "B" of *The Daily Mail* Architects' Competition (an £850 house) was equipped throughout with gas lighting, heating, cooking and water-heating appliances by the South Metropolitan Gas Company. The lighting equipment reached a very high standard, each fitting being chosen to blend well with the decorations of the room. All were controlled by switches. In the "Sun-trap House of Tudor Style," erected by the Potters Bar Estate, gas was again used for lighting. The lights in the drawing-room were particularly pleasing, being of the semi-indirect type, the mantles being obscured by glass shells carried on wrought-iron wall-brackets. The silk shades on the burners in some of the other rooms were well chosen to harmonize with their surroundings.

TRADE EXHIBITS.

In addition to the special exhibits already referred to, the trade exhibits of Messrs. Radiation Ltd., Thomas Potterton, Electrolux Ltd. (gas-operated refrigerators), Staines Kitchen Equipment Co., and many others, helped to bring to the notice of those in search of equipment for the "ideal" home the fact that the gas industry can render them a great service at a low cost, and can at the same time help all in their efforts towards the attainment of the ideal of smokeless cities bathed in sunshine.

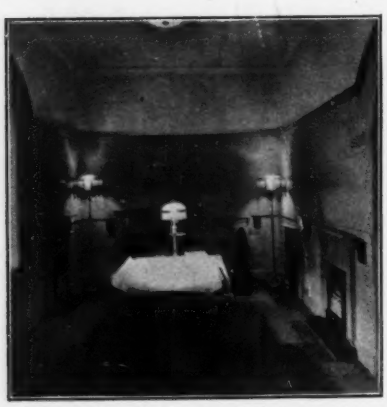

FIG. 8.—The Section for Architects and Builders, showing Gas Fires and Surrounds suitable for housing schemes. Each fire and surround was hinged to enable architects and builders to examine the flues built in the thickness of the walls.

FIG. 9.—An All-Gas Kitchen, showing Gas Water-heater and Storage Tank, Coke Boiler, Gas Cooker, Gas-heated Clothes-drying and Airing Cabinet, Gas Iron, and a Refrigerator, which was operated by gas at a cost of only one penny for seven hours.

FIG. 10.—A model All-Gas Bathroom, showing a Bath Geyser, a smaller Geyser for providing an instantaneous supply of hot water at the hand-basin, and a gas-heated Towel Rail. The gas-lighting fittings were of simple but attractive design, controlled by switch.

TRADE NOTES & ANNOUNCEMENTS

LIGHTING WHIPPET RACE TRACKS.

Whippet racing, that very popular sport and pastime in Lancashire and the North of England has in the past usually been held only at week-ends, owing to its not having been possible to hold meetings except during daylight. With artificial lighting, however, it is now possible to hold meetings after daylight and cater for patrons each evening, thus adding enormously to its popularity.

The proprietors of the whippet racing track at the Central Athletic Grounds, Liverpool, first conceived the idea of running evening meetings, and approached the Liverpool Branch of the General Electric Co. Ltd., of Magnet House, Kingsway, W.C.2, who were requested to draw up and submit a scheme of lighting in order to render this possible.

The results obtained have surpassed the most sanguine expectations of the promoters. The whole course, which is of grass, is 200 yards long, and thirty three angle-type G.E.C. reflectors were installed, each being equipped with a 500-watt Osram gasfilled lamp. The extent of the success of the scheme is apparent from our photograph, which was taken solely by the aid of the artificial illumination provided, and is untouched in any way.

In designing this scheme there were several quite unusual features to be taken into consideration, one of the most important points being that there should be entire absence of shadow owing to the dogs baulking at dark patches on the ground. The need for uniform illumination will be appreciated when it is stated that the 200-yards course is usually traversed by the dogs in about 12 seconds. It was also necessary that the eyes of the dogs should be free from glare and that the light sources should therefore be most effectively shielded.

Our photograph was taken from the starting point, and it will be noted that an even intensity of glareless lighting prevails throughout the course, while all light sources are concealed; the fittings being installed 18 feet from the ground and spaced equidistant along the centre of the track. The electrical contractors were the Sumner Engineering Co. Ltd., 20, Rathbone Street, Liverpool.

As a result of the success of this lighting scheme, orders have been placed with the G.E.C. for lighting other similar tracks.

FIG. 1.—Lighting of Whippet Racing Track at the Central Athletic Grounds, Liverpool.

SIEMENS ELECTRIC FITTINGS.

A good range of fittings is illustrated in a new list issued by Messrs. Siemens and English Electric Lamp Co. Ltd. Amongst these bowls and globes, both of the plain and decorative type, are included. Special interest attaches to the enclosed ornamental forms, which were exhibited at the opening meeting of the Illuminating Engineering Society last November, and, we understand, have proved very popular with the public.

MASONIC TEMPLE LIGHTING.

A somewhat special problem is afforded by the lighting of Masonic temples. Particulars of an interesting example reach us from the British Thomson-Houston Co. Ltd. This Masonic temple at Douglas was lighted by eight B.T.H. " Eye Rest " fittings, each containing a 500-watt gasfilled lamp, so that a feature of the installation was a complete absence of glare. In the case of ornate interiors, as in this case, the lighting up of the ceiling forms an essential point in the whole scheme, so that indirect methods have special opportunities. We understand that the installation was carried out by Messrs. V. A. Bellamy, electrical contractors, of Douglas, to the specification of the architect, Mr. W. H. Lomas.

CONTRACTS CLOSED.

The following contracts are announced :—

MESSRS. METRO-VICK SUPPLIES LTD. :

Southern Railway; for the supply of " Cosmos " standard gasfilled and vacuum lamps, traction, train-lighting and carbon-filament lamps, automobile and battery lamps and flashlight lamps, for a period of six months from March 1st to August 31st, 1927.

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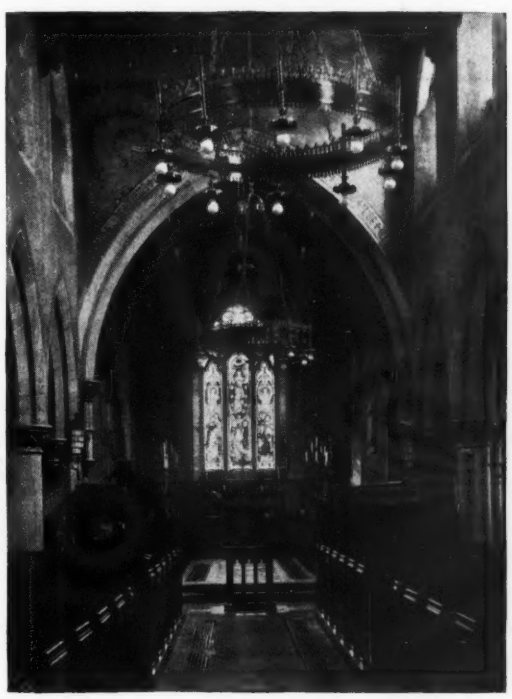
Southern Railway; for the supply of Siemens incandescent electric lamps (vacuum and gasfilled and train-lighting) for six months from 1st March, 1927, until August 31st, 1927.

CHURCH LIGHTING WITH " ARGENTA " LAMPS.



We give above an interesting photograph of the installation carried out at the Old Humberstone Church, Leicester. The fittings employed were originally candle fittings, but these have been inverted, and the lamps burn in a vertical position, cap downwards. An interesting point is that no shades whatever are used, as excellent results are obtained by using " Argenta " lamps alone. The fittings comprise two 10-light and four 6-light. The chancel is floodlighted by means of four lamps from each of three beams, none of the lamps being visible from the nave. Messrs. The Midland Dynamo Co. Ltd. were responsible for the carrying out of this work, and Philips lamps are used throughout.

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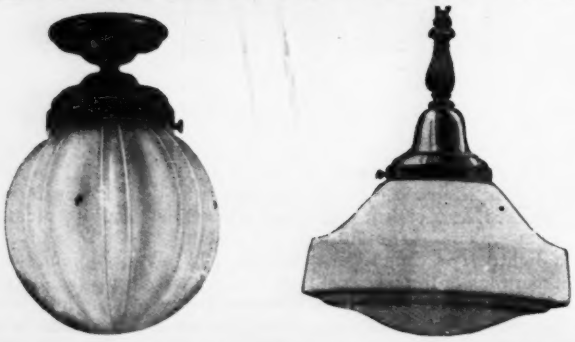

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FLOODLIGHTING OF *THE GLASGOW HERALD* NEW LONDON PREMISES.

The older buildings in Fleet Street, London, the hub of the newspaper world, are rapidly being superseded by fine modern structures provided with efficient lighting arrangements, electric lifts, central heating, adequate ventilation and every other known means of promoting business efficiency.

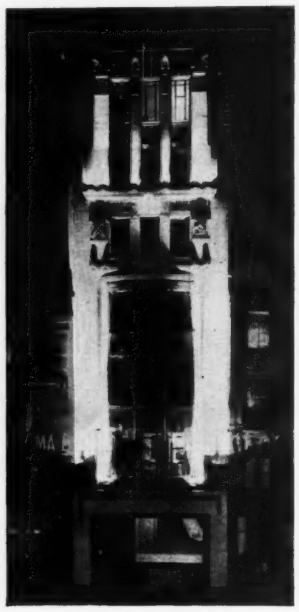
The latest example is the new London office of *The Glasgow Herald*, *The Bulletin* and *The Evening Times* group of Scottish papers. Although the frontage is comparatively small the architects, Messrs. Percy Tubbs, Son & Duncan, 30 John Street, Bedford Row, W.C., have succeeded in designing a building of very striking yet dignified appearance. As it was planned from the beginning to floodlight the front of the building, this fact was taken into special consideration in order that the design of the façade should lend itself effectively to this method of illumination. It was also necessary to make provision for the concealment of the projectors which are situated on the building itself.

The new *Glasgow Herald* building is a complete breakaway from all the conventions and traditions of commercial architecture. Sandwiched between two perfectly respectable and entirely unremarkable blocks of offices, it stands as herald and harbinger of the brighter London that is yet to be. But for the floodlighting of the façade, the significance, indeed even the form and outline, of the building would have been entirely lost at night. As it is, they are, if anything, more evident and challenging by night than by day.

The floodlighting installation consists of projectors and Mazda lamps supplied by the British Thomson-Houston Co., Ltd. For illuminating the upper portion of the building six B.T.H. type 795 floodlight projectors are used, each fitted with a Mazda 250 watt lamp. These projectors are concealed behind a specially constructed ornamental stone coping. The lower section of the building is illuminated by two B.T.H. type 793 floodlight projectors each with a Mazda 1,000 watt lamp and two B.T.H. type 795 projectors each with a Mazda 250 watt lamp. The two larger projectors are enclosed in ornamental bronze brackets and the two small ones are concealed by means of small bronze screens.

A photograph of the building, reproduced on this page by the courtesy of *The Glasgow Herald*, shows the effectiveness of this installation.

As regards the interior lighting arrangements, the general lighting equipment consists of standard B.T.H. enclosed fittings, together with a number of special bronze and wood fittings designed by the architect, Mr. Duncan. The whole of these fittings were supplied by The British Thomson-Houston Co., Ltd., and the electrical contractors responsible for the installation were Messrs. Frederick McGhee & Co., Windsor House, Victoria Street, S.W.1.



The new London offices of *The Glasgow Herald* showing the front of the building illuminated by means of ten B.T.H. floodlight projectors fitted with Mazda lamps. The fittings used for the interior lighting were also supplied by The British Thomson-Houston Co., Ltd. (Photograph reproduced by the courtesy of *The Glasgow Herald*.)

INEXPENSIVE FITTINGS FOR ELECTRIC LIGHTING.

We have also to acknowledge the receipt from The British Thomson-Houston Co., Ltd., of an attractive leaflet illustrating a variety of inexpensive electric fittings. This deals with domestic equipment, hall lanterns, dining room pendants, electroliers and bedroom pendants, which are presented at an opportune moment, as we are approaching the spring-cleaning period, when the renewal of fittings in many houses comes up for consideration.

MODERN SHOP WINDOW LIGHTING.

Yet another item from The British Thomson-Houston Co., Ltd., is the reproduction of an article in the *Electrical Times* by Mr. W. Millner. The article contains some sound general advice on window lighting, and attention is drawn to the profitable results from high intensities. The author also illustrates the uses of auxiliary equipment, including " spot " and colour units, and there is a series of diagrams illustrating different systems of spacing reflectors corresponding to varied intensities.

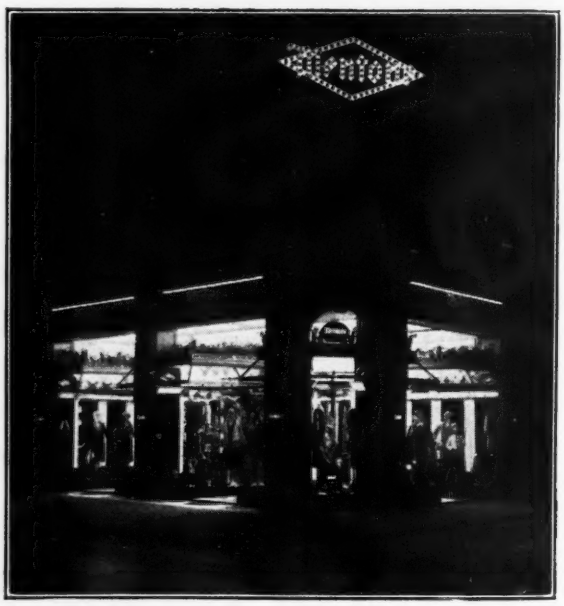
EMVEE LAMPHOLDERS.

A leaflet from Messrs. Metro-Vick Supplies, Ltd., illustrates the merits of the " Emvee " lampholders, to which we have previously drawn attention. Good features are ease of wiring, saving in cost, less risk of short circuit, etc., and it is mentioned that this type of holders has been approved by Government Departments and Railway and Steamship Companies, and is being adopted in increasing quantities by industrial buyers.

MESSRS. KELVIN BOTTOMLEY & BAIRD LTD.

New London Showroom.

We are informed that Messrs. Kelvin Bottomley & Baird Ltd., who are sole manufacturers of K.B.B. " Uviation " lamps for ultra-violet light therapy and K.B.B. Macbeth Artificial Daylight lamps, are discontinuing their branch at Hither Green. For the greater convenience of London and country clients they have now opened a new showroom at Imperial House, Regent Street, London, W.1. At the new premises all the latest models will be available for inspection and demonstration, and all enquiries by letter, telegram (" Heliolite," London) and telephone (Gerrard 7327) should be addressed as above.



SHOW-WINDOW LIGHTING AT MENTON'S (NEW OXFORD ST., LONDON).

Shop-window lighting in the case of large stores, etc., has now been brought to a fine art, the principle that the light should not, as in the past, be thrown into the eyes of prospective customers, but upon the goods displayed, being generally accepted. A glance at the illustration shows a perfect example of show-window lighting—Menton's, New Oxford Street, W.C. —the absence of blinding glare is most marked, whilst the gowns, etc., are so illuminated as to emphasize all their subtle charms. As will be seen, little or no light is wasted on the pavement, practically all being thrown on to the goods displayed. Philips Lamps are used throughout, there being approximately 2,000 lamps in all, including Striplites, colour-sprayed and sign lamps. The lighting effects were arranged by F. W. Barnard, Ltd., 5-6 Wells Street, Jermyn Street, S.W.

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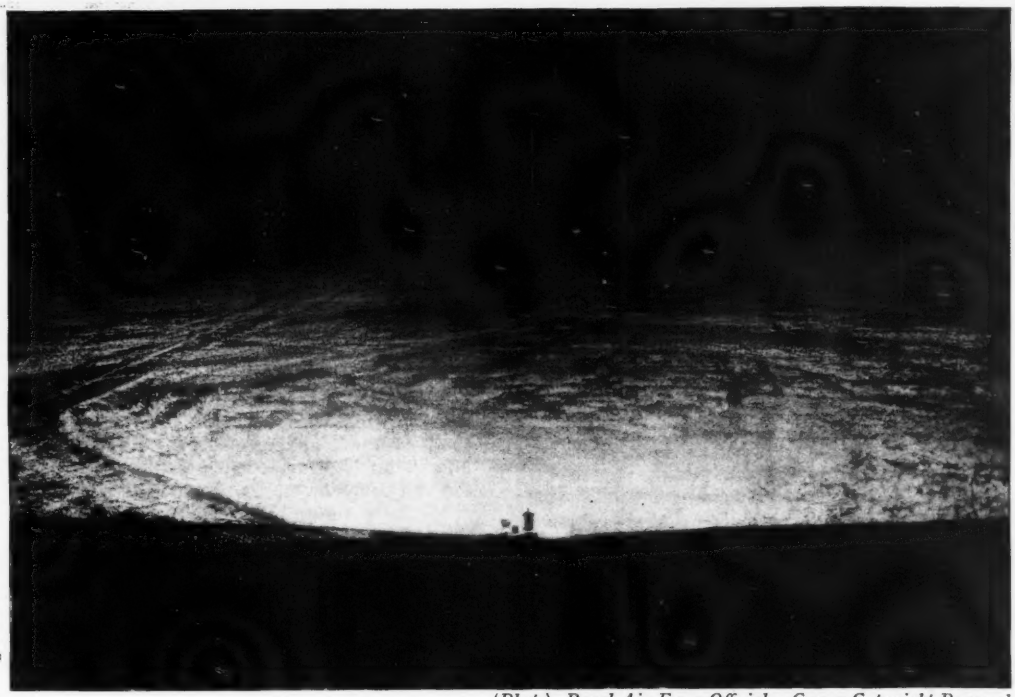

AND FLOODLIGHTS

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Floodlight on Farnborough Aerodrome

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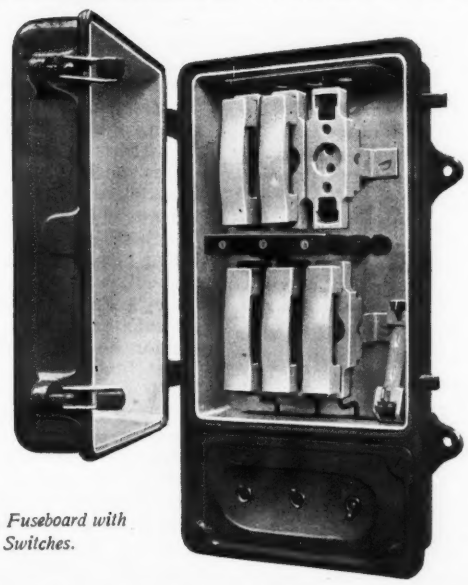

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SWITCHES IN SEPARATE COMPARTMENT

REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

PROCEEDINGS OF THE OPTICAL CONVENTION, *Parts I and II; pp.* 1,051. *Price £3 1s. 3d, including postage: Catalogue of the Exhibition, 6s. net. (Published by the Optical Convention, 1, Lowther Gardens, Exhibition Road, London, S.W.7.)*

In a previous issue we mentioned the forthcoming publication of the Proceedings at the Optical Convention in volume form. The two imposing volumes containing the papers (nearly 100 in number) and the discussions are now to hand. A full account of the Convention was given in this journal last year,* when we drew attention to the very wide range of the papers, many of which are of direct interest to illuminating engineers.

In Part I we have the Presidential Address, delivered by the President (Sir Frank Dyson), and the first 35 papers, and it is in this volume that most of the papers dealing primarily with various aspects of illuminating engineering (largely contributed by members of the Illuminating Engineering Society) occur. Amongst these may be noted Mr. Gaster's paper on "Illuminating Engineering in Relation to Optics," in which a general survey of the ground common to the two subjects is given. There is also the group of papers dealing with photometry, including contributions on the integrating photometer (Mr. R. C. Fox), photo-electric photometry (Messrs. N. R. Campbell and M. K. Freeth), the use of incandescent electric lamps as sub-standards (Messrs. W. Barnett, B. P. Dudding and G. T. Winch), portable illumination photometers (Mr. A. K. Taylor), ships' navigation lanterns (Mr. E. H. Rayner), and two papers on the photometry of projection apparatus and beams (Mr. J. W. T. Walsh and Colonel Sylvester Evans). The group of papers in the section on colour includes an analysis of problems in the woollen and worsted industry (Messrs. S. G. Barker and H. R. Hirst), various papers dealing with instruments and colour vision, and the very comprehensive paper on colorimetry by Mr. J. Guild. Of the more purely optical papers in this volume several contain matter bearing on illuminating engineering, notably those in which reference is made to the relation between illumination and visual defects. The papers in Vol. II are mainly optical, most being concerned with lenses and optical instruments; though here, too, there is a group of contributions dealing with kinematography that deserve attention. Of papers of general interest we may mention especially Professor Rankine's survey of problems involved in "speaking films," Mr. Fournier d'Albe's discussion of the uses of selenium and the optical analysis of sound, and several papers of a historical nature. We must also not forget the paper by Messrs. H. Banister, H. Hartridge and R. J. Lythgoe on "The Influence of Illumination on Visual Acuity," a subject that has recently received attention from the Illumination Research Committee of the Department for Scientific and Industrial Research.

Students of optics will also find much of interest in the summary of the remarkably complete series of exhibits of historic apparatus displayed at the Convention—probably one of the most representative ever assembled.

In a review of this comprehensive series of papers it is naturally only possible to select a few out of the varied list of contributions for special reference. On referring back to our issue last year readers will find a general survey of the papers, but even this was necessarily general in treatment. By the aid of the volumes now available readers will be able to study all the papers and discussions in detail.

The volumes as a whole present an admirable survey of recent progress in optics, and should prove most valuable for permanent reference. The paper and printing are good, and liberal use has been made of insets of illustrations on art paper. The production reflects great credit on Mr. T. Smith, the Chairman of the Papers Committee, Mr. Thomas Martin, the Secretary of the Convention, and others who shared in the very considerable amount of work involved in their preparation.

* *The Illuminating Engineer*, May, 1926.

THIRTY YEARS IN THE PUBLIC SERVICE; *by Rose E. Squire (late Deputy Inspector of Factories and Principal in the Home Office), with an introduction by Sir Edward Troup, K.C.B., K.B.E. (Nisbet & Co. Ltd., London, 1927, pp. 238.)*

(Specially contributed.)

To readers of *The Illuminating Engineer* this book should make a special appeal, because of Miss Squire's intimate association with the study of lighting in factories and workshops, both as an inspector of factories and as a member of the Home Office Departmental Committee appointed to deal with this subject in 1915. The work of the Committee is reviewed in Chapter XIII of Miss Squire's book, but the important share taken by her in these developments, of which I can speak with personal knowledge, would hardly be gathered from Miss Squire's own account. On her, very largely, depended the interpretation of recommendations on lighting and their shaping to accord with official practice. Her immediate recognition of the importance of good lighting was joined to a clear perception of the danger of unduly rigid requirements. This led her to give full support to the view that it was premature at that time to impose rigid standards of working illumination. The way in which the problem was dealt with is now familiar to our readers. It was in complete accord with the traditions of the Home Office, which were illustrated by the cordial welcome given to Miss Squire and Mr. D. R. Wilson on occasions when they addressed Industrial Councils and Trade Boards on illumination. In the author's words "the outstanding feature of all these meetings was the great interest (and, I must add, the astonishing ignorance!) displayed."

It is this spirit of comradeship, both with workers and managers of factories, that has enabled the Home Office Factory Department to develop their work with such remarkable success, and to bring about almost without friction a revolution in industrial practice. These changes would doubtless not have been effected without legal powers, to which appeal can ultimately be made. But how seldom, considering the immense numbers of factories visited, are these powers exercised! A much more potent influence than the law has been the general recognition that the factory inspector comes as an adviser and friend, and that the measures enforced are in the interests of workers and employers alike.

It has naturally taken years for a more enlightened attitude amongst employers and workers to be established. Miss Squire's experiences go back to the very early stages of factory inspection. The description given of the wretched conditions under which work was then done seem almost incredible to-day. Employers were often unable to realize that operations could be conducted not only more humanely, but more efficiently, by paying attention to hygiene. In many cases—the manufacture of matches is an example—the prohibition of dangerous processes quickly led to the discovery of methods at once safer and cheaper to carry on. Only a great personality could have persevered in those early days. Again and again one is struck by Miss Squire's courage and tenacity in playing what was often a lone hand. Many of the experiences are told with a touch of humour. Such incidents as the discovery of two laughing young persons disguised as a bolster in bed, and Miss Squire's amusing encounter on a back stairs with an agitated manager waving his hands and crying, "Fly, fly! the inspectors are here!" would, one supposes, scarcely occur nowadays. But one is struck mainly by the pathos of the lot of many of these girls and women, working under what would now be considered insupportable conditions, yet often needing protection against themselves, in their fear that their livelihood might be endangered. Small wonder that they soon learned to trust the woman inspector as a friend, to whom they could confide other difficulties besides those incidental to their work.

Miss Squire's book covers a range of experiences such as can have fallen to the lot of few women, even in these days. One reads of her adventures in Ireland in obtaining evidence against

the iniquitous " Truck " system of payment, and of her campaign against unfair penalizing of workers by fines. Later, with Mr. (now Sir Arthur) Steel-Maitland as her colleague, she became one of the " persons of tact and skill " authorized to collect evidence for the Royal Commission on the Poor Law. At the outbreak of war she took a leading part under the Welfare Department of the Ministry of Munitions. There is, perhaps, no phase of our history which better illustrates the adaptability of the Home Office Factory Department than their record in this war period, when much of the organization patiently built up in past years might have been irretrievably lost. Later years saw a resumption of activities at headquarters, as Principal in the Home Office, when such subjects as the lighting of factories occupied the author's attention.

It is well that Miss Squire should have thus presented her experiences of factory work, extending over more than 30 years. The book is not only a shining record of faithful service to the nation, but a source of hope and inspiration to those who, like the writer of this note, look for still greater advances in industrial hygiene and efficiency in years to come. By Miss Squire's retirement the nation loses a great public servant, but no doubt there will be opportunities when it can still benefit by her ripe experience, and we hope and believe that her continued good health and strength will enable her to enjoy the leisure that is so well deserved. L. G.

Personal

Dr. S. English, D.Sc., F.I.C., F.Inst.P., late Senior Lecturer in the Department of Glass Technology, Sheffield University, has joined the staff of Holophane Ltd., of Elverton Street, Westminster, as Research Engineer for the investigation of problems connected with and the development of the use of glass in all types of illumination.

A Correction

In our last issue (p. 93) two letters were inadvertently interchanged in the name of the " Horstmann " Time Clock. We imagine that the device is sufficiently well known for no reader to have been confused by this slip. We understand that the Horstmann type of controller is generally adopted by the Tottenham District Light Heat and Power Co. for street lamp control and other purposes.

PHOTOMETRY

BY

JOHN W. T. WALSH

M.A. (Oxon.), M.Sc. (Lond.), A.M.I.E.E., F.Inst.P.

Member of the National Illumination Committee of Great Britain; General Secretary of the International Commission on Illumination.

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For form of application write, quoting reference, A.149, to the Chief Superintendent, Royal Aircraft Establishment, Farnborough, Hants, to whom completed form should be returned not later than 14th April, 1927.

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Gas at the British Industries Fair

It is interesting to observe that the gas industry was well represented at the British Industries Fair, Birmingham, special attention being paid to gas lighting. On entering the exhibition buildings at Castle Bromwich, says *The Gas World*, the visitor is immediately faced with an excellent example of the British gas industry's products in the form of an impressive and efficient display of gas lighting, for which the Birmingham Corporation Gas Department is responsible. Building "A" is lighted by 1,000 candle-power high-pressure lamps. These are supplied through two Tilley's 1,000 cubic feet per hour compressors, which are placed on a stand and form an attractive little exhibit in themselves. In case some of the visitors should be so unobservant as to miss the fact, a suitable notice is prominently displayed on this stand informing the public that the building is lighted throughout by gas. Buildings "B" and "C" are also lighted by 1,000 candle-power high-pressure lamps, supplied from two 4,000 cubic feet per hour compressors, which again form an exhibit of their own. The main gangway—approximately 700 ft. long—is lighted by three-light auto low-pressure burners. The roadways round the exhibition are lighted by six-light low-pressure lamps. This year a new main entrance to the building has been constructed, and this is lighted by one 4,500 candle-power high-pressure gas lamp.

Problems in Lighting Statues

The need for care in illuminating statues and memorials was strikingly illustrated in the case of the Lincoln Memorial, at Washington, the work of the famous sculptor, Daniel French. This statue is considered a masterpiece. It was, therefore, a great disappointment when it was found that the daylight illumination completely distorted the statue's expression. In this great memorial, daylight is admitted through very thin marble slabs in the roof, and it was hoped that the soft rays coming through this medium would display the statue at its very best. But it turned out that on sunny days strong light coming in through the entrance was reflected off the floor on to the face of the statue, giving it a singular "frightened" expression. This effect is now being remedied by placing strong floodlighting units behind the slabs, giving an illumination so strong as to counteract the effect of natural light reflected from below. The *General Electric News* (U.S.A.), in referring to this incident, reproduces photographs of the face of the statue before and after this addition, and the difference is very striking. Artificial light is thus coming to the assistance of daylight. The incident shows that natural light, as well as artificial light, may have a distorting effect on sculpture if injudiciously used.

Electric Lighting: Competitions for Children

An ingenious competition for popularizing the applications of electricity was recently organized by the North East Coast W.O.B. Committee, competitors being invited to suggest the most effective form of "slogan."

In view of the difficulty of judging it was decided by the Committee to divide the prize money into four prizes of £2 and six of 10s. After the slogans had been judged it was discovered that the son and daughter of Mr. J. H. Parker, Borough Electrical Engineer of West Hartlepool, had been awarded prizes. When acquainted of this fact they declined to accept the prizes, and requested that the money be divided among the other four winners making their prizes 15s.

The following is a list of the prize-winning slogans:
Light is Life, Win £2,000 and make life "Light."
Have Electricity and Save your Energy.
Everything Bright with Electric Light.
If Ease you'd enjoy, Electricity Employ.
Electric Leisure, Light for Pleasure.
Electrify for Light and Leisure.
Electrify for "Matchless" Homes.
The Electric Way to Develop a Banking Account.
Electricity Lightens the Present, £2,000 the Future.
Electricity—It's Matchless.